ON THE SPECIFIC CHARACTERS OF THE HADDOCK (*GADUS ÆGLEFINUS*, LINN.), WHITING (*GADUS MERLANGUS*, LINN.); *GADUS POUTASSOU*, RISSO; *GADUS ARGENTEUS*, GUICHENOT; *GADUS SAIDA*, LEPECHIN; *GADUS OGAC*, RICHARDSON; *GADUS NAVAGA*, KÖLREUTER; WITH A KEY TO THE SPECIES OF GADUS FOUND IN NORTHERN WATERS.

By H. CHAS. WILLIAMSON, M.A., D.Sc., F.R.S.E.,
Marine Laboratory, Aberdeen.

(Reprinted from the Twenty-sixth Annual Report of the Fishery Board for Scotland—Part III.—published 24th January 1909.)

GLASGOW:
PRINTED BY JAMES HEDDERWICK & SONS LIMITED,
At the "Citizen" Press, St. Vincent Place.

100—Wt. 2569—3/1909.

V.—ON THE SPECIFIC CHARACTERS OF THE HADDOCK (*GADUS ÆGLEFINUS*, LINN.), WHITING (*GADUS MERLANGUS*, LINN.); *GADUS POUTASSOU*, RISSO; *GADUS ARGENTEUS*, GUICHENOT; *GADUS SAIDA*, LEPECHIN; *GADUS OGAC*, RICHARDSON; *GADUS NAVAGA*, KÖLREUTER; WITH A KEY TO THE SPECIES OF GADUS FOUND IN NORTHERN WATERS.

By H. CHAS. WILLIAMSON, M.A., D.Sc., F.R.S.E., Marine Laboratory, Aberdeen. (Plates VIII.–XIII.)

CONTENTS.

INTRODUCTION.

This paper continues the research on the classification of the Gadidæ. The two preceding parts were published in the *Twentieth* and *Twenty-fourth Annual Reports of the Fishery Board for Scotland*, Part III., in 1902 and 1906. They dealt with six species, and in the present contribution the remaining seven species are discussed.

I have been indebted to several zoologists for the courteous supply of specimens of the rarer species, and my thanks are specially due to Mr. E. W. L. Holt, Dublin, Drs. Job. Schmidt and A. C. Johansen, Copenhagen, for examples of *G. poutassou* and *argenteus*; to Professor Brandt, Kiel, Dr. Pappenheim, Berlin, and Professor Vanhöffen, Charlottenburg, for specimens of *G. saida* and the loan of examples of *G. ogac*; and to Dr. Breitfuss, St. Petersburg, for a specimen of *G. saida*. Dr. Hector Jungersen, Copenhagen, also kindly favoured me with the loan of *G. ogac* and *G. navaga*.

The Fishes Examined.

The sizes of the fishes (in cm.) and the localities from which they were obtained were as follows:—

G. æglefinus.—The haddocks were obtained from Scottish waters, and also from Iceland. The Scottish specimens, some of which were fresh, the others preserved in formaline or alcohol, measured—5 at 13, 6 at 14, 6 at 15, 16, 17, 4 at 20, 21, 21, 23, 25, 30, 36, 37, 37, 56, 56, 60, 61. The haddocks from Iceland, which are known in the Aberdeen Fish Market as "Jumbo Haddocks," were examined fresh; they measured 72, 72, 73, 75, 76, 77, 77, 84 cm.

G. merlangus (Diagram).—The whitings were from Scottish waters. Some were fresh, the others preserved. They measured 5, 6, 6, 7, 7, 10, 11, 11, 12, 12, 16, 17, 4 at 18, 20, 20, 21, 21, 22, 23, 23, 24, 24, 35, 36, 46, 48 cm.

G. poutassou (Fig. 4).—Most of the specimens examined had been got by Dr. Fulton during his trawling experiments in the North Sea. One large specimen, 37 cm. long, lent by Mr. Holt, was captured on the West of Ireland, and the poutassou sent by Drs. Schmidt and Johansen were got at 63°21′N. : 21°48′W. in the young-fish trawl, with 100 metres of wire. All were preserved in alcohol or formaline. Their lengths were as follows:—9, 7 at 10, 7 at 11, 6 at 12, 8 at 13, 4 at 14, 6 at 15, 3 at 16, 17, 17, 37 cm.

G. argenteus (Fig. 2).—Some sent by Mr. Holt were got 80 miles W.N.W. of Cleggan, Co. Galway, Ireland, 11th May, 1905; the others, from Drs. Schmidt and Johansen, came from 57°32′N. : 7°E., 31st May, 1907. Two had been captured by Dr. Fulton. All were preserved in alcohol or formaline. They measured 6, 7, 7, 8, 8, 9, 10, 10, 11, 12, 13, 14, 15, 17 cm.

G. saida (Fig. 3).—The specimens of this species were preserved in alcohol. Three were obtained by Professor Vanhöffen at Karajak Greenland; the fourth, from Dr. Breitfuss, was got in the Barents Sea They measured 16, 16, 17, 19 cm.

G. ogac (Fig. 1).—Two specimens, measuring 63 cm. and 33·5 cm. in length, had been obtained in Greenland. The former was captured by Professor Vanhöffen. The latter was lent by Dr. Jungersen.

G. navaga (Fig. 84).—One specimen of this species measuring 17·9 cm. was lent by Dr. Jungersen.

The characters by which the fishes were tested consisted, as in the former portions of the research, of measurements on the fish—Body-Dimensions—and the enumeration of the Vertebræ, Fin-rays, etc.—Enumeration-characters. These characters numbered in all 36. In addition, the the species were compared by the shape of the skull, abdominal cavity, and ovary—Internal characters.

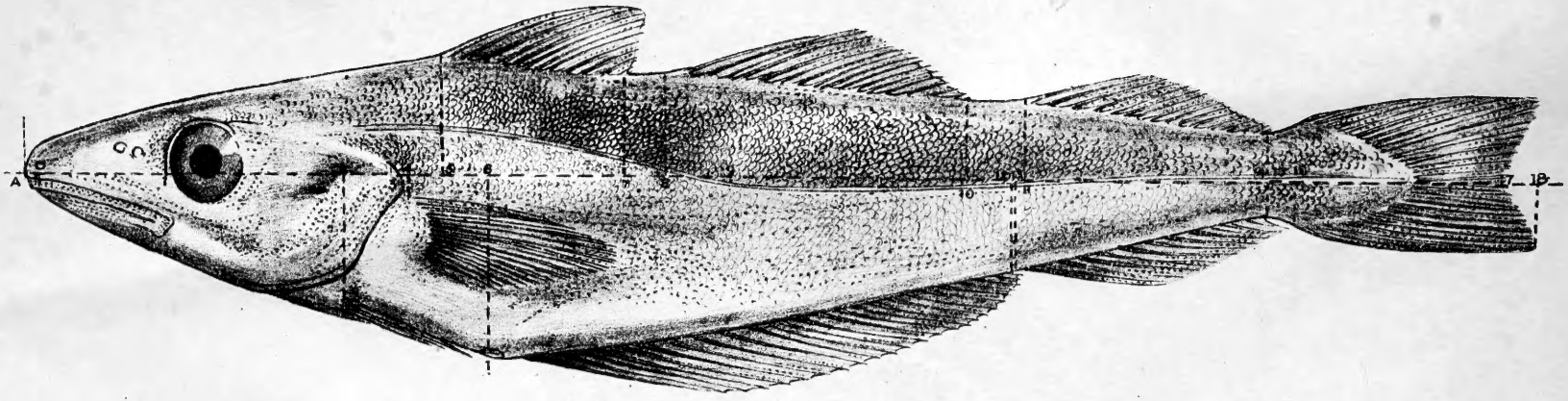
The work has been carried on by the same methods throughout, and with identical characters. Some characters which were adopted in the first two papers have been dropped, and a few characters connected with the abdomen have been introduced. This has necessitated a further examination of certain of the species already treated.

External Characters—The Body-Dimensions.

The body-dimensions which were recorded were of two classes—(*a*) distances of certain points on the body from the anterior end of the fish, and (*b*) girth at three points, and the dimensions of various organs, *e.g.*, the eye and fins.

(*a*) The distances were all measured from the anterior end of the fish when the mouth was closed. In some species this point was the premaxilla, in others the mandible. The distance from the anterior end to each point on the body was taken along the lateral axis. The lateral axis is the line oining the anterior tip of the fish to the middle of tail—Y Z in diagram.

DIAGRAM.



A.H.W.

Gadus Merlangus.

Nat. Size.

The measuring board described in "On the Mackerel of the East and West Coasts of Scotland," *Eighteenth Annual Report of the Fishery Board for Scotland*, p. 295, 1900, was used for this part of the research.

The accompanying diagram shows the points on the fish to which the distances were measured.

The point *a* represents the anterior end of the fish (mouth closed).

Distance from the tip of mandible to premaxilla, ...	*a* to 0.
Anterior edge of the orbit (for the length of the snout), ...	*a* to 1.
Base of first ray of ventral fin, ...	*a* to 2.
Opercular cleft, ...	*a* to 3.
Base of first ray of pectoral fin, ...	*a* to 4.
Anus, ...	*a* to 6.
Base of first ray of first dorsal fin, ...	*a* to 5.
„ „ last „ „ „ „ „	*a* to 7.
„ „ first „ „ second „ „	*a* to 8.
„ „ last „ „ „ „ „	*a* to 10.
End of bend of lateral line, ...	*a* to 9.
Base of first ray of third dorsal fin, ...	*a* to 11.
„ „ last „ „ „ „ „	*a* to 14.
„ „ „ „ „ first anal „	*a* to 12.
„ „ first „ „ second anal „	*a* to 13.
„ „ last „ „ „ „ „	*a* to 15.
Ventral base of tail fin, ...	*a* to 16.
End of middle rays of tail (=Length of Fish), ...	*a* to 17.
Tip of ventral ramus of tail, ...	*a* to 18.

(*b*) *The Girth at the Pectoral Region, at the Anus, and at Root of Tail.*—A thread was passed round the fish at the position and the two ends crossed. A sharp knife was then drawn across the ends, cutting the thread to the size of the girth.

Lengths of the Pectoral, Ventral, and First Dorsal Fins.—In each case the fin was measured from the base of the first ray to the farthest edge of the fin.

Diameter of the Eye.—For this the horizontal diameter of the orbit was taken.

The interorbital space was measured on the top of the head.

The length of the ventral ramus of the tail was measured from the base of the first fin-ray of the caudal fin on the ventral edge to the extreme tip of the ramus.

For the spread of the tail, *i.e.*, the breadth, dorso-ventrally, the tail was not distended to its fullest length; it was simply flattened out.

Length of Barbel.—For the measurement of the lengths of the barbel, fins, and interorbital space, and diameter of the eye, a pair of compasses was employed.

Enumeration-Characters.

Number of rays in each of the dorsal and anal fins.

Internal Characters.

Number of vertebræ. The ural and hypural elements are together counted as one vertebra.

Number of the vertebra bearing the first hæmal arch.

Distance of the first hæmal arch (crown of the arch) from the anterior end of the fish.

Shape of the skull and clavicle.

The colour of the peritoneum.
The number of the lobes of the urinary bladder.
Position of the ureter with respect to the swim-bladder.
Number of pyloric cæca.
Shape of the ovary.
Shape of the abdominal cavity.

Standard—the Length of the Fish.

All the measurements have been represented as percentages of the length of the fish. The length is measured from the anterior end of the fish, mouth closed, to the end of the middle rays of the tail fin.

These have been summarised, and the range of variation with the number of variants for each species is shown in the following table. There are also included the ranges of variation for the Gadids treated in the two previous papers. From the latter the number of variants is omitted, but these can be found in the papers just mentioned. Certain new measurements have been made on the species already treated.

MEASUREMENTS REPRESENTED AS PERCENTAGES OF THE LENGTH OF THE FISH. RANGE OF VARIATION.

	Girth.			Length of Fins.			Eye. Horiz. Diam.	Inter-orbital Space.	Tail.		Length of Barbel.
	Pectoral	At Anus.	Tail.	Pectoral	Ventral.	First Dorsal.			Length Ventral Ramus.	Spread.	
G. callarias	48·3-54·4	44·5-50·2	12-15	11·2-14·2	9·9-11·3	16·5-19	3·3-4·6	5·5-6·6	15·3-18·2	14-17·4	3·7-5
G. ogac	46·4	36·3,48·3 (2)*	10·3, 14 (2)	15·2 (2)	12·6,14·3 (2)	18·2,18·6 (2)	4·8, 5 (2)	7·7, 8 (2)	16, 17·3 (2)	13·2	5, 5·4 (2)
G. navaga	45·8	40·2	13·4	13	10·6	12·8†	5	6·4	..	..	1·9
G. æglefinus (Scotland) 13-37 cm.	45·5-54·5 (31)	44·3-53·4 (31)	12·4-14·8 (31)	13·4-16·1 (31)	11·4-15·6 (31)	16-23·3 (29)	6·1-8 (31)	6·3-7·6 (31)	18·4-21·3 (31)	7·1-13 (24)	·5-1·8 (16)
G. æglefinus (Scotland) 56-61 cm.	..	..	13-14·2 (4)	14·1-15·4 (4)	9·5-10·8 (4)	15·9-18·2 (4)	5·3. 6·2 (2)	6·6-7·1 (3)	..	..	1·4-1·8 (4)
G. æglefinus (Iceland) 72-84 cm.	..	..	14·3-16·2 (4)	14·4-17·4 (8)	9·8-11·6 (8)	16·6-20 (8)	5-5·6 (8)	6·5-8·2 (7)	19·3-19·9 (4)	12·9-16·3 (4)	1·2-1·8 (8)
G. merlangus	38·9-48·4 (25)	40-49·6 (25)	11·9-17·9 (25)	11·9-16·4 (28)	8·8-13 (28)	12·7-17·9 (21)	4·9-8·1 (28)	6-8 (27)	17·3-21·8 (25)	6·8-12·9 (25)	·4-·9 (9)
G. luscus	55-63	55-69	13-15	16-19	14-17	18-24	5-7	5-6	18-20	9-10	6·5, 6·9
G. minutus	46-55	48-58	11-14	15-18	12-16	16-19	6-9	5-6	17-18	5-8	5-6
G. virens	43·9-50·7	47·3-56·7	12·8-15·6	10·9-14·3	5·7-8·6	11·9-14·3	3·3-6	5·5-7·5	16·6-19·3	14·2-19·2	·5-1‡
G. pollachius	42·9-51·9	45·4-59·3	14-17·2	9·9-14·7	4·2-6·6	11·6-14·8	3·5-6·7	4·7-7·3	14·8-19·9	10·5-17·9	..
G. esmarki	37·50	36-52	9-12	16-22	10-16	15·2-16·3	6-9	4-7	17	8-12	2-3
G. argenteus	43·3-56·4 (13)	37·4-52·6 (13)	11·7-15·6 (13)	9·1-11·9 (4)	..	15·1 (1)	9·4-12·4 (14)	5·8-8·3 (14)	..	..	..
G. saida	35·1-43·1 (4)	30·5-35·5 (4)	8-10 (4)	17·8-19·7 (4)	17·4-20·2 (4)	14·2-15·4 (4)	6-6·6 (4)	5·9-6·8 (4)	18·9-20 (4)	9·5-16·6 (4)	·6-·9 (4)
G. poutassou	30-38·3 (31)	27·4-37·6 (29)	9·6-13 (30)	13·2-16·3 (38)	3·7-6·9 (36)	11-11·9 (3)	5·4-7·5 (37)	4·5-6·5 (27)	16·2-19 (28)	6-8·2 (20)	..

* The figures within brackets are the numbers of variants. The numbers of the variants for the species already described have been published in the previous papers.
† The first dorsal fin was a little frayed.
‡ The barbel was found equal to 1 per cent. of the length of the fish in a virens measuring 9·4 cm. in length.

Measurements Represented as Percentages of the Length of Fish. Range of Variation—*continued.*

	Distance from the Anterior End of the Fish—Mouth Closed.											
	Tip of Mandible.	Tip of Premaxilla.	Orbit.	Ventral Fin.	Opercular Cleft.	Pectoral Fin.	Anus.	First Dorsal.		Second Dorsal.		End of First Anal.
								Beginning.	End.	Beginning.	End.	
G. callarias ..	·5-1·2	..	7·5-8·9	22-24·6	23·7-26·3	26-28·4	43·9-47·3	28·6-30·9	42-44·2	44-45·8	63·5-66·2	64·6-67·6
G. ogac	·4, 1·2 (2)	..	6·9, 7·4 (2)	17·9, 21 (2)	23·2 (2)	25·3,27·3 (2)	46·2, 50·6-52 (2)	30·4, 32 (2)	44·7, 46 (2)	46·8,48·3 (2)	64, 64·7 (2)	65, 67·6 (2)
G. navaga	1·4	..	6·7	18·7	21·2	22·3	39·6	29	40·7	43	59·7	61·4
G. æglefinus (Scot.) 13-37 cm.	1-2·6 (28)	..	6·2-8·7 (30)	18·6-24·6 (30)	23-26·9 (30)	24·7-27·8 (30)	38·4-42 3 (29)	23·9-28·9 (30)	37·4-41·7 (30)	40·3-44·3 (30)	61-65·6 (30)	61·9-66·9 (30)
G. æglefinus (Scot.) 56-61 cm.	·5-1·4 (4)	..	7·4-8 (3)	..	23·7-24·6 (4)	..	41·2,41·6 (2)	26·1-27·6 (4)	38·2-40·4 (4)	41·6-43·1 (4)	63·4-67·1 (4)	65·1-68 (4)
G. æglefinus (Iceland) 72-84 cm.	·8-2·2 (8)	..	6·6-8 (8)	20-21·9 (4)	22·4-24·9 (8)	24·2-26·4 (8)	39·8-43·9 (7)	24·5-27·3 (8)	36·6-40·3 (8)	40-43·9 (8)	62·8-65·4 (8)	65·5-68 (8)
G. merlangus ..	·3-·9 (13)	..	6-9 (25)	20·5-26 (24)	22·5-26·9 (25)	24-28·5 (25)	29·7-35·8 (24)	27·9-31 (25)	38·9-43 (25)	41·2-46·6 (25)	57-66·4 (25)	60·5-69 (25)
G. luscus	·5	..	5-6	16-18	20-22	21-24	22-29	24-27	36-39	38-41	63-66	61-69
G. minutus ..	·4-·5	..	3-6	17-23	18-21	21-24	30-35	24-27	35-38	37-40	61-65	60-69
G. virens	..	·4-·9	6·7-8·4	21·2-23·3	22·4-24	23·5-25·5	36·4-42·4	30-32·3	41·3-43·7	43·3-46·5	64·6-72·3	61·2-70·4
G. pollachius ..	..	·7-2·7	7·9-10·8	21·6-25	22-25·7	23·4-27·4	33·3-37·3	31·5-35	41·9-45·9	44·3-49	60·5-69·2	63·8-70·8
G. esmarki	..	·5-1	5-8	18-23	15-22	21-25	32-38	23-29	35-40	37-42	60-64	60-65
G. argenteus ..	..	·3-3·3 (12)	5·8-9·1 (13)	22·4-29·9 (12)	24·4-27·3 (2)	25-31·5 (12)	38·6-43·3 (12)	28·6-33·2 (13)	39·8-44·8 (13)	43·3-49·8 (13)	56·6-63 (13)	57·3-66·4 (13)
G. saida	..	·6-1·2 (4)	6·5-7·4 (4)	21·3-23 (4)	21·4-23 (4)	25-26·3 (4)	41·7-44·7 (4)	28-30·7 (4)	38·7-42 (4)	44·6-46·3 (4)	57·7-60 (4)	60-63·2 (4)
G. poutassou ..	..	·6-2·6 (19)	6·7-8·7 (33)	21·2-25 (34)	21·9-24·9 (28)	23·9-28·4 (36)	29-33·3 (34)	32·8-35·5 (36)	39·9-45·8 (36)	44·3-50·5 (36)	52·5-59·2 (36)	62·8-67·6 (36)

MEASUREMENTS REPRESENTED AS PERCENTAGES OF THE LENGTH OF THE FISH. RANGE OF VARIATION—*continued.*

	DISTANCE FROM THE ANTERIOR END OF FISH—MOUTH CLOSED.							
	THIRD DORSAL.		SECOND ANAL.		TAIL.		Lateral Line—End of Bend.	First Hæmal Arch.
	Beginning	End.	Beginning	End.	Ventral Base.	Tip. Ventral Ramus		
G. callarias	65·8-68·3	78·9-81·7	67-69·7	79·4-81·7	81·9-84·2	97·2-100·5	57·7-64·8	51-52·9
G. ogac	68·2, 69·2 (2)	80·5, 80·9 (2)	68·8, 70·9 (2)	80·8, 81·7 (2)	83·7, 84·1 (2)	100·4, 101 (2)	53·7, 56·9 (2)	..
G. navaga	65·8	79·2	65·3	80·3	83·7	101·6	48	..
G. æglefinus (Scotland) 13-37 cm.	63·2-66·8 (30)	77·5-81·6 (30)	63·8-68·2 (30)	78·2-82·4 (30)	81·8-85 (29)	102-104·4 (31)	67·7-74·4 (19)	51
G. æglefinus (Scotland) 56-61 cm.	65·8-68·1 (4)	80·2-81·6 (4)	66·4-68·6 (4)	81·4-82·7 (4)	83·9-84·5 (4)	101-103·5 (4)	..	..
G. æglefinus (Iceland) 72-84 cm.	64·5-66·9 (8)	79·5-82·2 (8)	66-69·3 (8)	80-82·9 (8)	82·4-84·9 (8)	101·9-104·4 (8)	..	..
G. merlangus	60·5-67·7 (25)	77·7-81·5 (25)	62·3-69 (25)	77·8-82·8 (25)	80·6-84·9 (25)	100·3-102 (27)	61·4-70·7 (22)	..
G. luscus	64-68	77-79	End of 1 A	79-84	81-84	100-101	56-69	44
G. minutus	62-67	79-82	63-68	80-86	83-85	101-106	46-62	..
G. virens	67·9-72·8	81·2-85·4	67·3-73	80·6-85·4	84·6-88·4	102-106·4	47·9-74·7	56·5-61·2
G. pollachius	67·4-71·6	79·3-84·7	66-72·3	78·2-83·9	83·6-86·8	100-104·3	47·9-63·7	53·3-55
G. esmarki	62-70	78-84	62-67	79-84	84-86	102	48-58	44
G. argenteus	61·6-69·7 (13)	74·9-84·7 (13)	63·2-66·4 (13)	76-86·3 (12)	80·7-89·6 (13)	102·103·3 (3)	64·7	..
G. saida	63·7-65·7 (4)	80·9-82 (4)	63·7-66·8 (4)	81·5-8·3 (4)	83·9-85·7 (4)	104-104·5 (4)	46·2-49·6 61·9-69·4	..
G. poutassou	63·7-70·7 (36)	80-85·5 (36)	64·3-68·9 (36)	86-87·4 (36)	82·9-88·4 (31)	101-106·5 (40)	53·2-85·9 (5)	..

The data set out in these tables are not of direct value from the point of view of specific discrimination. But a detailed examination of them will reveal wherein lie diagnostic characters.

One species may be readily separated on the first examination of the fish by some prominent distinguishing mark, as, for example, the black area on the side of æglefinus. But in another the formulation of a specific description is difficult, not always because the fish resembles its neighbours closely, but owing to the difficulty of expressing the difference. And that obtains, even although the two species may be quite easily separated, when compared side by side. An accurate and detailed description of a single fish will not serve for a specific description in every case. In some instances it might do so, but not in the genus Gadus.

A perfect specific description would be sufficient to enable one to diagnose a fish by itself, without having recourse to direct comparison with another fish. But that is not altogether necessary, since it is usually possible to make use of pictures of some or all of the species. It must, however, be comprehensive enough to admit of the diagnosis of a damaged fish. This can only be assured when the scheme of classification is an extended one, working along various lines, by each of which the species may be reached, or at least found in a reduced group. A fish may be quite normal although deprived of some of its so-called specific characters.

A callarias, 69 cm. in length, was caught near Aberdeen. It had been mutilated. All its fins had been trimmed. The pectoral and ventral fins had been cut off short, movable stumps only being left. All the dorsal and anal fins and the tail fin had been partly cut away. One eye had been destroyed. All the fins had healed and the fish was well nourished. The stomach contained crabs.

The tables given above are useful in showing characters which are hidden when the fish is examined; but they are mainly of service in estimating the exact value of the characters which have otherwise attracted attention. In a group of fishes, as that of the genus Gadus, it is not possible to separate the different members by a simple scheme, because the character which may be of value for separating two species may be quite neutral in the other eleven members of the genus. It is therefore necessary to take the characters of the fish seriatim, making each one a basis for classification. It has usually been thought necessary to subdivide the genus by the test of a single character—for example, by the question of whether the upper or the lower jaw forms the more anterior point of the fish when the mouth is closed. Then in each sub-group the individual members were separated by other characters. Theoretically this is a convenient arrangement, but in practice it is of little value in some cases. For the first selected character may not be readily recognisable in some specimens, and in that case the diagnosis may not be obtained.

A character which is very noticeable in examining different members of the genus Gadus is the varying size of the eye. The size of the eye has been compared by previous authors to the length of the snout and to the length of the barbel. The species may then be grouped according as the eye is less than, equal to, or greater than the snout. An examination of the tables given above will reveal how the species will range themselves under this classification. But while in one species the result will be at once apparent, in another the relationship may be doubtful. That is due to the range of variation in each character. For example, in callarias the diameter of the eye equals 3·3–4·6, while the length of the snout is 7·5–8·9. In this fish the eye is always less than the snout. But in merlangus the relationship is more obscure, the eye measuring 4·9–8·1, while the snout equals 6–9. In such a case it is necessary to refer to the measurements* of each fish, and find out the relationship of the eye and snout in each individual specimen. The result of that enquiry is to show that in merlangus the eye was, in the majority of cases, less than the snout, but it may be equal with it, or it may exceed the snout by a very little. In those fishes in which the lower jaw projects in front of the upper the tables do not show the size of the snout. They give the position of the orbit with reference to the tip of the mandible. The distance between the mandible and the premaxilla must be subtracted from the orbit distance in order to get the length of the snout. In all cases the corroboration of the character must be made on the fishes. This character, the relation of the snout and eye, is a good one for certain fishes, and of less value for others. There is probably hardly a single character or comparison between two characters but may be of more or less value for diagnosis.

There is a certain amount of evidence to indicate a change in the size of certain characters with an increase in the length of the fish. Thus the eye was found to be larger in small æglefinus, virens, pollachius, and to a certain extent merlangus, than in big fishes of these species. In the comparison in length between the pectoral fin and the first dorsal fin of

* The measurements made on the fish are not published here.

pollachius, in one fish measuring 30 cm. in length the former was slightly the greater, while in four specimens measuring 36–93 cm. in length the first dorsal fin was the greater.

The comparative lengths of the paired fins form a specific character of some value. In each species there is a more or less extensive range of variation. In some, *e g.*, virens, the range is short; in the majority it is much greater than in that species.

During the research it was noticed that there might be in a species a character that was specially variable, what might be termed an unstable character. Thus in esmarki the relation between the lengths of the pectoral and first dorsal fins was much more subject to variation than in the other species.

Fin-rays.

The other external characters which have been adopted for classification are the numbers of rays in the unpaired fins. The rays of the paired fins have not been counted except in three species. The number of rays in the ventral fin was found constant at 6. The rays of the pectoral fin varied in luscus and minutus from 18–20, and in esmarki from 19–20. The number of specimens examined were respectively 4, 8, and 5. In the caudal fin 38 and 40 rays were found in luscus, 38 and 39 in minutus, and 40 in esmarki. In this character, 2, 3, and 1 specimens respectively were counted.

The number of rays in each fin is shown for each fish in the following tables :—

THE NUMBER OF VERTEBRÆ AND FIN-RAYS IN GADUS ÆGLEFINUS.

Length. Cm.	Number of Vertebræ.	Vertebra bearing First Hæmal Arch.	Fin-rays.				
			1 D.	2 D.	3 D.	1 A.	2 A.
13	54	23	16	22	21	24	23
13	53	22	16	21	21	24	22
13	55	..	14	22	20	25	21
13	54	23	16	22	21	24	22
13	53	21	13	20	22	24	22
14	53	21	15	22	23	24	25
14	54	..	16	21	21	24	22
14	54	22	14	23	22	24	23
14	54	21	17	21	22	24	22
14	53	22	15	21	22	25	22
14	54	23	15	22	21	24	22
15	54	22	16	22	21	25	22
15	53	21	15	22	20	26	22
15	56	23	15	22	22	25	23
15	53	22	15	20	21	25	23
15	54	22	15	21	19	23	21
15	53	..	14	20	22	24	24
16	53	23	16	22	23	26	23
17	54	21	15	21	21	26	23
20	53	21	16	23	22	23	23
20	..	..	16	23	20	25	22
20	54	21	16	22	20	23	22
20	..	22	14	22	21	24	21
21	54	21	16	23	22	25	23
21	54	22	14	22	20	24	22
23	52	21	15	21	21	26	22
25	54	21	16	22	21	24	25
30	54	22	14	23	22	24	23
36	54	21	16	22	22	24	24
37	54	21	15	25	22	27	24
37	53	22	16	21	21	25	22
56	53	22	16	19	21	24	24
56	55	22	17	22	21	26	23
60	54	21	18	23	21	26	23
61	53	20	14	21	20	25	22
*72	55	22	15	20	21	26	23
*72	54	..	16	22	22	26	22
*73	53	21	15	25	20	27	23
*75	53	21	15	21	21	26	22
*76	54	22	16	21	22	25	21
*77	54	22	15	22	23	24	24
*77	53	21	14	22	20	27	21
*84	55	22	14	22	21	26	24

* Iceland Æglefinus.

THE NUMBER OF VERTEBRÆ AND FIN-RAYS IN GADUS MERLANGUS.

Length. Cm.	Number of Vertebræ.	Vertebra bearing First Hæmal Arch.	Fin-rays.				
			1 D.	2 D.	3 D.	1 A.	2 A.
5	54	21	13	21	21	33	24
6	55	..	14	23	21	34	22
6	54	..	12	20	..	31	23
7	54	..	13	19	19	33	22
7	55	21	14	20	21	35	22
10	54	20	13	21	23	35	23
11	54	21	14	21	19	33	21
11	54	22	14	20	21	33	23
12	55	21	14	19	19	34	22
12	55	21	13	21	20	34	22
16	54	20	15	23	21	34	24
17	55	21	13	20	21	32	22
18	54	20	12	20	21	30	23
18	54	23	14	21	21	30	23
18	54	20	13	23	20	34	22
18	55	20	14	20	21	30	23
20	53	20	12	19	20	33	23
20	55	21	15	21	21	35	23
21	55	21	14	22	18	34	20
21	55	21	12	23	19	32	22
22	54	21	13	19	20	29	22
23	55	21	13	23	20	35	24
23	53	22	14	19	19	29	20
24	54	21	15	23	22	37	25
24	54	20	14	23	20	35	24
35	57	23	16	21	23	37	24
36	56	21	14	20	24	37	26
46	55	21	14	23	21	35	24

THE NUMBER OF VERTEBRÆ, FIN-RAYS, AND PYLORIC CÆCA IN GADUS POUTASSOU.

Length. Cm.	Number of Vertebræ.	Vertebra bearing First Hæmal Arch.	Fin-rays.					Number of Pyloric Cæca.
			1 D.	2 D.	3 D.	1 A.	2 A.	
10	57	..	14	13	24	36	26	..
10	57	..	13	12	24	37	27	10
10	56	25	13	12	23	38	26	..
10	57	26	12	11	24	34	24	9
11	58	26	..	..	..	..	..	10
11	57	25	13	14	23	40	27	10
11	58	..	12	13	25	37	26	11
11	57	26	14	13	26	..	24	11
11	57	26	12	12	24	39	25	11
11	58	26	12	11	23	37	25	11
12	57	25	13	12	25	36	26	..
12	58	..	13	12	25	37	25	15
12	58	25	13	11	26	35	25	11
12	58	26	13	13	23	37	25	12
12	58	26	..	..	..	..	..	..
13	58	27	13	14	26	37	26	11
13	55	25	12	13	26	40	27	..
13	57	27	13	15	26	42	27	9
13	57	..	..	..	..	..	..	13
13	58	..	14	11	24	33	26	12
13	57	..	13	12	25	36	27	..
13	57	25	13	12	27	39	28	11
13	58	25	14	13	25	41	27	..
14	58	25	13	11	24	35	26	11
14	57	25	13	11	24	36	26	10
14	57	26	13	12	24	35	26	11
14	58	25	12	13	25	39	26	10
15	57	25	12	12	26	39	27	11
15	57	25	13	13	26	37	27	11
15	58	26	14	12	25	38	27	11
15	57	24	12	11	24	37	25	..
15	57	.	13	10	23	39	28	..
16	57	25	12	13	26	38	27	10
16	57	26	13	13	24	39	26	9
16	57	25	12	13	25	39	28	11
17	56	25	12	11	25	39	26	12
17	58	26	12	12	25	40	27	11
37	..	..	14	12	25	37	26	..

THE NUMBER OF VERTEBRÆ, FIN-RAYS, AND PYLORIC CÆCA IN GADUS ARGENTEUS.

Length. Cm.	Number of Vertebræ.	Vertebra bearing First Hæmal Arch.	Fin-rays.					Number of Pyloric Cæca.
			1 D.	2 D.	3 D.	1 A.	2 A.	
6	39	13	12	12	18	17	16	..
7	41	14	11	13	16	15	17	..
7	42	14	11	13	17	18	..	..
8	42	14	10	14	18	17	17	..
8	41	14	12	15	17	17	18	..
9	41	14	9	13	17	17	17	..
10	40	14	10	13	17	15	17	7
10	41	..	11	13	17	17	17	..
11	42	14	11	13	17	17	17	..
12	42	14	12	14	17	18	17	..
13	42	..	11	13	17	17	17	..
14	42	14	12	15	16	15	16	10
15	..	..	12	14	15	18	16	..
17	42	14	12	13	18	18	18	8

GADUS SAIDA.

16	56	20	11	14	24	17	25	30
16	55	19	12	15	22	20	21	31
17	57	20	15	16	21	22	22	24
19	..	..	14	15	22	16	22	..

GADUS OGAC.

33·5	..	..	17	22	18	21	19	..
63	..	..	17	17	18	21	20	..

GADUS NAVAGA.

17·9	..	..	14	20	21	24	22	..

In the next table are shown the ranges of variation in the numbers of vertebræ and fin-rays that have been found during this research. The particulars, with the numbers of variants, have been already shown in this and the two previous papers. This table may be used for the specific discrimination by means of the fin-rays.

NUMBER OF VERTEBRÆ AND FIN-RAYS.

RANGE OF VARIATION.

SPECIES.	Number of Vertebræ.	Vertebra bearing the First Hæmal.	FIN-RAYS.				
			First Dorsal.	Second Dorsal.	Third Dorsal.	First Anal.	Second Anal.
G. callarias . .	51-53	19 (3)	12-15	17-22	18-20	19-24	17-19
,, ogac * . .	...	...	13-17	17-20	17-20	20-23	17-20
,, æglefinus, Scotland . .	52-56	20-23	13-18	19-25	19-23	23-27	21-25
,, æglefinus, Iceland . .	53-55	21 and 22	14-16	20-25	20-23	24-27	21-24
,, navaga † . .	about 58	...	12-14	16-20	20-25	21-24	22-25
,, merlangus. .	53-57	20-23	12-16	19-23	18-24	29-37	20-26
,, luscus . .	48-49	16-17	12-15	21-26	18-22	31-36	18-22
,, minutus . .	48-51	15-18	11-15	20-26	19-23	26-31	20-24
,, virens . .	54-55	24, 25	12-15	19-24	19-24	25-32	20-24
,, pollachius . .	50-55	22, 23	12-14	17-22	17-20	25-34	17-21
,, poutassou . .	55-58	24-27	12-14	10-15	23-27	33-42	24-28
,, esmarki . .	52-55	18-19	14-18	21-29	23-29	24-32	24-30
,, argenteus . .	39-42	13-14	9-12	12-15	15-18	15-18	16-18
,, saida ‡ . .	55-57	19-20	10-14	12-18	18-24	15-22	17-25

* The data furnished for this species by Vanhöffen and Smitt have been included.
† The data furnished by Kölreuter and Smitt for this species have been included.
‡ The data furnished for this species by Günther, Vanhöffen, Smitt, and Jensen have been included.

It is not necessary to discuss the external characters individually, although it may be well to append notes on certain of them. The results of my enquiry into the varied relationship are set out in the key. The intention has been to express the characters on broad lines. Very accurate measurements cannot be adopted in a diagnosis, owing to the fish being liable to damage or distortion. Distortion or injury may render some of the test-characters inapplicable.

GIRTH.—The girth is of considerable importance as indicating the shape of the fish. It is, however, a character that should be measured on fishes in good condition. Where preserved fishes are used only approximate values can be got, and even in fresh material the soft tissues may yield more in one specimen than in another. It would be an advantage to have some characters which would give a definition of the body of the fish, since each species has a general form distinctly different from its neighbours. In this connection a comparison between the species in the dorsal aspect would be of value.

TH SPACE BETWEEN THE SECOND AND THIRD DORSAL FINS.—The wide gap on the dorsal edge between the second and third dorsal fins is a prominent character in poutassou. It is a character that varies

much in the genus. In poutassou it reaches its maximum, and in minutus and luscus it sometimes vanishes through the meeting of the two fins. A useful standard with which to compare this space is the length of the base of the second dorsal fin.

The Position of the First Dorsal Fin.—In some species this fin begins nearer the snout than in others. In æglefinus, luscus, minutus, and esmarki, the first dorsal fin is placed farther forward than in the other members of the genus, while in poutassou it occupies the furthest posterior position.

It is an advantage to have the position fixed by comparison with other points on the fish. Thus the beginning of the pectoral fin may be associated with the first dorsal, and the extent of the distance between made a distinguishing character. In some species this character seems to be fairly well fixed, *e.g.*, in æglefinus, while in others, *e.g.*, esmarki and argenteus, it is subject to a considerable range of variation. In several instances, moreover, it has been found that this distance is relatively greater in large fish than in the small specimens of the same species. This distance has been compared to the length of the snout.

Lateral Line.—The lateral line is of specific value, both in its shape and in the form of its scutes. The arctic species saida has a very characteristic lateral line; in it the line forms a bend below the lateral axis, as well as the usual bend above. The line formed by the meeting of the ventral and dorsal muscle segments of the trunk is taken as the lateral axis in this connection. In several species the scutes are noticeable from their wide separation.

Number of Fin-rays.—In some cases it would be possible to fix the species by the number of the fin-rays, but there are cases where the fin-ray formulæ of a certain fish might fit into two species. Nevertheless the number of fin-rays forms a very important character.

Internal Characters.—These do not call for special discussion here. They are included in the key.

Discrimination-Characters.

The characters which I have selected, upon which to found a key for the discrimination of the species, are the following:—

The more anteriorly projected jaw, upper or lower.
The position of the anus with reference to the dorsal fins.
The form of the lateral line.
The shape of the tail fin.
The diameter of the orbit compared with the length of the snout.
The presence and size of the barbel.
Comparison in length between the pectoral and ventral fins.
Comparison in length between the pectoral and first dorsal fins.
The position of the first dorsal fin with reference to the pectoral fin.
The relation of the second and third dorsal fins to one another.
The relation of the anal fins to one another.
The relation of the girths at the pectoral and anal regions.
Prominent colour marks.
Separation of the species by length.
The deciduous character of the scales.
The number of rays in the unpaired fins.
The number of vertebræ.
The number of the vertebra bearing the first hæmal arch.
The colour of the inside of the mouth.

The abdominal cavity—the colour of the peritoneum; the first hæmal arch; the form of the abdominal cavity; the shape of the swim-bladder.
The form of the urinary bladder.
The position of the ureter with respect to the swim-bladder.
The shape of the ovary.
The pyloric cæca.
The skeleton. Comparison between the skulls and certain bones of the different species.

KEY.

In cases where measurements are adopted in the key, they are made on similar lines to the measurements described on pages 98 and 99. A pair of compasses will be suitable for this purpose. Distances are measured along the lateral axis.

In the key the æglefinus from Scotland and Iceland are combined.

I. Lower Jaw :—

a. shorter than upper jaw.. .....callarias, ogac, æglefinus, navaga, merlangus, luscus, minutus.
b. of same length as upper jaw...virens (sometimes in young), minutus (sometimes).
c. projects in front of „ „ ...virens, pollachius, poutassou, argenteus, esmarki, saida.

II. Anus :—

a. in front of the first dorsal fin...poutassou.
b. below the beginning of the first dorsal fin..... ..luscus.
c. below the first half of the first dorsal fin.....luscus, pollachius, merlangus.
d. about the middle of the first dorsal fin .....merlangus, minutus.
e. below the second half of the first dorsal fin .....minutus, virens, esmarki.
f. below the end of the first dorsal fin .....æglefinus, argenteus, saida, navaga.
g. below the interval between the first and second dorsal fins...æglefinus, argenteus, saida, callarias, ogac.
h. below the first half of the second dorsal fin.....callarias, ogac, æglefinus (in two specimens from Iceland the anus was immediately below the beginning of the second dorsal fin).

III. Lateral Line :—

a. straight, white... .....virens (white not always prominent in small specimens).
„ „ indistinct .....poutassou.
b. curved .....callarias, ogac, navaga, pollachius, minutus.
„ „ slightly.....æglefinus, merlangus, esmarki, argenteus, saida (see below).
„ curve double.....saida.
c lateral line black (usually jet-black) ....æglefinus.

c. lateral line, posterior part, white .....callarias (the white colour may not be noticeable in small specimens).

,, lateral line yellow or pale in fresh specimens .....merlangus.

Scutes of the Lateral Line.

A basis of classification may be made out of the extent to which the lateral line is continuous or broken up into separate scutes.

The lateral line is a continuous groove .....callarias, ogac, pollachius, merlangus, virens, minutus, æglefinus, luscus. An occasional break occurs at any part in the line. Thus in one callarias the scutes were separate, from the middle of the third dorsal fin backwards.

Lateral line broken up into scutes in its whole length .....saida.

Lateral line broken up into scutes from the beginning of the first dorsal fin backwards..... .....poutassou, argenteus, navaga.

Lateral line broken up into scutes from the end of the first dorsal fin backwards..... .....esmarki.

IV. Tail Fin, Posterior Edge :—

a. straight or convex.....callarias.

b. very slightly concave.....callarias (small), luscus.

c. concave..... } merlangus, minutus, ogac, pollachius,

,, distinctly forked..... } esmarki, argenteus.

d. deeply cleft.....æglefinus, virens, poutassou, saida.

V. Eye (Horizontal Diameter of the Orbit) :—

a. larger than the length of the snout.....luscus, minutus, argenteus, esmarki, saida.

b. eye and snout practically equal, being exactly the same size, or one or the other slightly the larger....æglefinus, merlangus, poutassou.

c. eye less than the snout.....callarias, ogac, virens, navaga, pollachius, æglefinus, merlangus.

d. eye oval, long axis vertical...pollachius.

VI. Barbel :—

a. absent.....pollachius, poutassou.

,, ,, replaced by two hooks...argenteus.

b. minute.....merlangus (white), virens (black), saida.

c. small, stumpy.....æglefinus, navaga.

,, ,, slender (in length about half the diameter of the eye).....esmarki.

d. long, stout..... ..callarias, ogac, luscus, minutus, navaga.

VII. Lengths of Pectoral and Ventral Fins :—

a. ventral fin longer than pectoral fin.....saida.
b. ventral fin equal to pectoral fin.....æglefinus, luscus, minutus.
c. ventral fin less than pectoral fin.....
„ ventral fin greater than half (·7–·9) the length of the pectoral fin.....callarias, ogac, æglefinus, merlangus, luscus, minutus, navaga, esmarki.
„ ventral fin about half (·4–·6) of the pectoral fin.....merlangus, virens, pollachius, esmarki, poutassou.
„ ventral fin less than half the pectoral fin.....pollachius, poutassou.

VIII. Lengths of the Pectoral and First Dorsal Fins :—

a. first dorsal distinctly greater than the pectoral.....callarias, ogac, æglefinus, argenteus, pollachius
b. first dorsal equal or about equal to the pectoral.....merlangus, virens, luscus, minutus, pollachius, navaga (?).
c. distinctly less than the pectoral.....poutassou, saida, esmarki.

IX. The Position of the First Dorsal Fin :—

a. The beginning of the first dorsal fin is just in front of the base of the pectoral fin...æglefinus.
b. The beginning of first dorsal coincides with the base of the pectoral fin.....æglefinus, esmarki.
c. The first dorsal begins close behind the base of the pectoral.....callarias, æglefinus, merlangus, luscus, minutus, esmarki, argenteus.
d. The distance between the pectoral and first dorsal fins is greater than the length of the snout .....virens, pollachius, poutassou.
„ The distance between the pectoral and first dorsal fins is equal to the length of the snout.....virens, pollachius, poutassou, minutus, esmarki, saida, navaga.
„ The distance between the pectoral and first dorsal fins is less than the length of the snout.....callarias, ogac, merlangus, luscus, minutus, virens, pollachius esmarki, argenteus, saida.

X. The Second and Third Dorsal Fins:—

a. united.....luscus (sometimes).
b. meet without uniting.....luscus, minutus.
c. The space between the second and third dorsal fins is equal to, or greater than, the length of the base of the second dorsal fin.....poutassou.
„ The space (2 D–3 D) is equal to four-fifths the base of the second dorsal fin.....poutassou.
„ The space (2 D–3 D) is equal to half the base of the second dorsal.....pollachius, argenteus.
„ The space (2 D–3 D) is equal to about three-eights of the base of the second dorsal...navaga.
„ The space (2 D–3 D) is equal to one-third or one-fourth of the base of the second dorsal.....ogac, merlangus, pollachius, esmarki, argenteus, saida.
„ The space (2 D–3 D) is equal to one-fifth of the base of the second dorsal fin.....æglefinus, merlangus, virens, pollachius, esmarki, saida, ogac.
„ The space (2 D–3 D) is less than one-fifth of the base of the second dorsal fin.....callarias, æglefinus, merlangus, virens, pollachius, luscus, minutus, esmarki.

XI. Anal Fins:—

a. united.....luscus, merlangus (sometimes).
b. First anal has a long base—reaches to second anal without uniting..... merlangus, minutus, esmarki, poutassou (pollachius, in some the first anal just fails to reach the second anal).
c. There is a gap between the first and second anal fins...callarias, ogac, æglefinus, virens, pollachius (adult), argenteus, saida, navaga.
d. The first anal fin ends in a rounded extremity in callarias, ogac, merlangus, pollachius, poutassou. It tapers away to nothing in virens. They vary a little in different fishes.

XII. Girth:—

a. Girth at pectoral region greater than the girth at anus.....callarias, æglefinus, merlangus, poutassou, argenteus, saida.
b. Girth at pectoral region equal to the girth at anus.....æglefinus, merlangus, poutassou, argenteus.

c. Girth at pectoral region less than the girth at anus ...ægleﬁnus, merlangus, luscus, minutus, virens, pollachius, esmarki, poutassou.

d. Girth at root of tail is twice, or more than twice, the interorbital space.....callarias, ægleﬁnus, merlangus, luscus, minutus, virens, pollachius, esmarki, poutassou, argenteus, navaga.

e. Girth at root of tail is over one and a half time, and less than twice, the interorbital space.....ægleﬁnus, merlangus, vireus, minutus, esmarki, poutassou, argenteus, ogac.

f. Girth at root of tail is not more than one and a half time the interorbital space...ogac, saida.

XIII. Prominent Colour Marks in Fresh Condition :—

a. Large black area on the side of the fish, below the first dorsal ﬁn.....ægleﬁnus.

b. Black patch on the axilla.....luscus.

c. Small black patch on the axilla.....merlangus, minutus, esmarki, saida, (poutassou ?)

d. Upper half of ﬁsh dark green...virens, young.
„ „ „ black..... „ large.
„ „ „ dark olive...pollachius.
„ „ „ light olive...merlangus.

e. Considerable quantity of amber colouring, scattered or general, on the dorsal half of the body..... .....callarias, merlangus, pollachius.

f. Silvery cheeks and sides.....luscus, minutus, argenteus, and ?

g. General dark-brown colouration of body, dorsum, and ventrum.....ogac.

XIV. Length of the Fish :—

a. up to 10 inches (25 cm.).....callarias, ogac, ægleﬁnus, merlangus, navaga, luscus, minutus, virens, pollachius, esmarki, poutassou, argenteus, saida.

b. between 10 and 17 inches (25–42 cm.).....callarias, ogac, ægleﬁnus, merlangus, luscus, minutus, virens, pollachius, poutassou, saida, [argenteus ?].

c. over 17 inches (42 cm.).....callarias, ogac, ægleﬁnus, merlangus, virens, pollachius.

XV. Scales very Deciduous.....luscus, minutus, argenteus, esmarki ?

XVI. Number of Rays in the Unpaired Fins.

See Table, p. 109.

XVII. Number of Vertebræ.

See Table, p. 109.

XVIII. Number of the Vertebra bearing the First Hæmal Arch

See Table, p. 109.

XIX. The Colour of the Inside of the Mouth:—

The inside of the mouth is black in pollachius.
" " " dark, bluish tinge, in virens.
" " " brown in ogac.
" " " white in callarias, merlangus, poutassou, æglefinus, luscus, minutus, argenteus, esmarki, saida (dull colour in spirit), navaga (yellowish in spirit).

XX. The Abdominal Cavity:—

The Colour of the Peritoneum:

Peritoneum steel-grey colour....callarias.
" black.....æglefinus, argenteus, poutassou, saida, esmarki.
" dark.....merlangus, saida, ogac.
" white.....pollachius, virens.

The First Hæmal Arch.

The number of the vertebra bearing the first hæmal arch varies with the species, as will be seen on reference to the table on page 109.

There is a marked difference in the shape of the first hæmal arch in different species. This is exhibited both in the size of the arch and also in its shape. Drawings of this bone for all the species, with the exception of *G. ogac and G. navaga*, are shown in Plate IV. The posterior side of the arch is represented, the vertebra resting on its anterior disc.

The arch may be round as in pollachius, fig. 39, or nearly round, the condition found in merlangus, fig. 65. The most common shape is that of a broad oval, and that form is found in callarias, fig. 61; virens, fig. 66; minutus, fig. 63; luscus, fig. 67; saida, fig. 59; and esmarki, fig. 64. Æglefinus, fig. 68; poutassou, fig. 57; and argenteus, fig. 58, have a narrow, oval arch.

Æglefinus is readily distinguished from the other species by its characteristic first hæmal arch. It bears two lateral wing-like expansions, fig. 68, which have no counterpart in the other species.

This wing-like expansion is repeated on the second arch, but it has disappeared on the third, a thickened ridge alone representing it. These lateral plates receive the ends of the swim-bladder. Sometimes the expansions are found on three of the 20–23 vertebræ. The first hæmal arch in this species is most commonly found on the 22nd vertebra, but it is also found on the 21st. It may happen that the arch is not complete, one side being short, although the other side may be continued downwards into the hæmal spine. If the hæmal spine is present on an imperfect arch, this is regarded as the first hæmal arch; but if the spine is absent and the arch incomplete, it has been neglected.

Facultative Hæmal Arch.—Occasionally a facultative hæmal arch is formed by the union of the ribs of the vertebra immediately preceding the first hæmal arch. In these cases there is no hæmal spine. Such an

arch may be formed also by the transverse processes being united inferiorly by cartilage in the aponeurosis that lines the bottom of the abdominal cavity. More than one case (æglefinus) was noted where one side only of such an arch was formed: the transverse process on the opposite side did not reach the floor of the abdomen. In minutus the three vertebræ in front of the first hæmal arch formed three facultative arches by means of their ribs, which met inferiorly in the tough fascia. In luscus, two of the ribs from the corresponding region formed almost complete arches.

As a rule the ribs cease on the anterior side of the first hæmal arch, and they are represented behind that point by a film of ligamentous tissue connecting the hæmal arches. In virens, however, a rib was found running obliquely downward from the first to the second hæmal arch.

The first arch is the largest, the succeeding arches becoming smaller, rapidly in some species, more gradually in others. The arches all slope more or less backwards.

The arch bears at its lower end a spine. It is shortest on the first arch, and gradually increases in size in succeeding vertebræ. The hæmal spines are long in æglefinus; in merlangus, poutassou, and saida they are markedly bent backwards from the arches.

The first hæmal spine is usually attached to the aponeurosis that lines the end of the abdominal cavity, and which binds the ends of the interspinous bones. This ligamentous tissue is continued posteriorly, forming the upper edge of the interspinous region. Some of the hæmal spines pass through it into the interspinous region, and are attached directly to the interspinous bones.

The hæmal arch always lodges the caudal artery and the caudal vein. It lodges these alone in saida, fig. 60. The kidney accompanies the blood vessels into the arches in all the other species which I have dissected. The conditions in ogac and navaga were not examined. The swim-bladder enters the hæmal arches in most of the species, *e.g.*, virens, fig. 74; pollachius, fig. 72; merlangus, fig. 62; luscus, fig. 71; minutus, fig. 80; poutassou, fig. 70; esmarki, fig. 75. In callarias, fig. 91, and æglefinus, fig. 81, the end of the swim-bladder reaches to the second hæmal arch. The swim-bladder does not enter the hæmal arches in argenteus, fig. 69, and saida, fig. 60.

The extent to which the swim-bladder and the kidney enter the hæmal arches may be here summarised:—

Callarias.—The swim-bladder is continued back to the second and third hæmal arch. It is bound tightly to the first and second arches; it is constricted much by the first arch.

Æglefinus.—The swim-bladder ends at the second hæmal arch, to which it is bound firmly below.

Merlangus.—The swim-bladder is continued backwards to the 8th or 9th hæmal arch.

Virens.—The swim-bladder extends back to the 4th, 5th, or 6th hæmal arch, tapering to a fine point. It is bound to the first hæmal arch.

Pollachius.—The swim-bladder extends posteriorly to the 10th or 11th hæmal arch.

Luscus.—The swim-bladder goes back to the 13th arch; the kidney seems to end at the 6th arch.

Minutus.—The swim-bladder ends at the 10th arch; the kidney was very small and not noticeable on the outside of the arches.

Poutassou.—The swim-bladder extends to the 6th arch.

Esmarki.—The swim-bladder ends at the 9th arch.

Argenteus.—The swim-bladder ends at the vertebra in front of the first hæmal arch. The first and second arches are filled with the kidney, which ends at the 3rd arch.

Saida.—The swim-bladder ends a little in front of the first hæmal arch; the kidney ends at the first hæmal arch.

The Form of the Abdominal Cavity.—In some cases the first hæmal spine ends the abdominal cavity, *e.g.*, callarias, fig. 91; æglefinus, fig. 81; virens, fig. 74; poutassou, fig. 70. In other species the cavity is continued posterior to that point, either above it, that is, into the hæmal arches, or below, into a sub-hæmal cavity formed between the hæmal spines and the interspinous bones of the first anal fin.

Of the former condition the following species are examples:—Pollachius, fig. 72; luscus, fig. 71; minutus, fig. 80; esmarki, fig. 75; argenteus, fig. 69. In these fishes the liver, ovary, and gut may extend into the hæmal arches. The fishes which have the sub-hæmal extension of the abdominal cavity are merlangus, fig. 62, and saida, fig. 60. None of the movable abdominal organs enter the hæmal arches, but they have room below for expansion. Poutassou, in which the hæmal spines are markedly bent backwards, fig. 70, might be regarded as having a slight sub-hæmal extension.

In many of these fishes the interspinous region of the first anal has a long stretch which is not directly supported by the vertebral column.

The peritoneum is loosely attached to the hind end of the abdominal cavity.

In esmarki a white matter of a soft and fatty appearance was found in the hæmal arches.

In saida the abdominal cavity is lofty, the vertebral column coming very near the dorsal edge.

The Shape of the Swim-bladder.—In the Gadids the swim-bladder is usually large. The anterior end is sometimes furnished with horn-like prolongations.

In callarias these are long and they have a spiral form. They pass round the head kidney and lie on top of it, between the branches of the vagus nerve and the muscles at the top of the clavicle.

Pollachius, fig. 85; merlangus, fig. 95; and virens, have two short horns. In one virens the horns were absent.

According to Kölreuter, the swim-bladder in navaga has two horns.

XXI. Urinary Bladder:—

The urinary bladder has two lobes.....	callarias, ogac, æglefinus, minutus, esmarki, argenteus, (saida). In argenteus the lobes are short. In saida one or two small swellings were noticed on the urinary bladder; in one example, however, none were seen.
The urinary bladder has no lobe	merlangus, luscus, virens, pollachius, poutassou.

XXII. The Position of the Ureter with respect to the Swim-bladder.

Species.	Number of Cases on Right Side of Swim-bladder.	Median in Position.	Number of Cases on Left Side of Swim-bladder.
Callarias. .	5	...	5
Æglefinus .	9	...	3
Merlangus .	12	...	3
Luscus . .	4	...	7
Minutus. .	25	...	14
Virens . .	6	...	6
Pollachius .	14	...	10
Esmarki. .	32	...	21
Pontasson .	7	...	8
Argenteus .	...	5	...
Saida . .	...	2	...

In certain of the species there appeared to be some indication that a sexual difference might be found in the character. Although the ureter was found in each sex on both sides of the swim-bladder, still there seemed to be a tendency for the majority of cases in each sex to be on one side.

In callarias the ureter leaves the kidney at the first hæmal arch; it pierces an extension of the wall of the swim-bladder.

In virens the ureter was found to leave the kidney at the second vertebra in front of the first hæmal arch.

In pollachius it left at the junction of the first and second vertebræ in front of the first hæmal arch.

In argenteus the ureter was median just behind the swim-bladder, which ended one vertebra in front of the first hæmal arch.

In saida the ureter issued behind the end of the swim-bladder, *i.e.*, at the first hæmal arch.

XXIII. The Ovary.

There is much difference between the species in the shape of the ovary. This organ varies in the comparative lengths of the anterior and posterior lobes. In some the posterior lobes of the ovary are fused in part or in their whole extent.

Then in side view the ovary may be distinctly triangular in shape, exhibiting a great increase in dorso-ventral thickness at the oviduct, or the ovary may show very little taper from the middle to either end.

For this purpose large roes of each species have been examined. They are ovaries containing yolked eggs. The ovary of virens was, however, unripe, and for esmarki a small unripe ovary probably lately spent has been drawn. I did not have an ovary of poutassou sufficiently large.

In side view the following are markedly triangular in shape:—Pollachius, fig. 94; virens, fig. 13; luscus, fig. 73; minutus, fig. 77; esmarki, fig. 97.

The two hind lobes are short in callarias, fig. 90; aeglefinus, fig. 87; esmarki, fig. 97.

The two hind lobes are about the same length as the anterior lobes—merlangus, fig. 79; saida, fig. 78.

The two hind lobes are fused together—virens, argenteus, fig. 92; ogac.

The two hind lobes are fused in part of their extent—pollachius, fig. 96. The two hind lobes are fused up to the point A.

In the other species the hind lobes are bound together by mesentery—callarias, fig. 90; æglefinus, fig. 87; saida, fig. 78; merlangus, fig. 79; esmarki, fig. 97; luscus.

The ovary is pigmented black—ogac, fig. 76.

The oviduct in merlangus, callarias, and luscus is long.

The oviduct is short in æglefinus.

Saida.—Vanhöffen found in the ovary of this form 12,700 eggs measuring ·5 mm. in diameter. The fish was obtained in December at Karajak. In another fish obtained in the same month the yolked eggs in the preserved fish are yellow, resembling the egg of *Sebastes marinus*; they measured ·7 mm. in diameter.

Merlangus.—A full roe of a fish 30 cm. long contained the shrunken remains of old eggs in the beginning of the oviduct. The posterior lobes of this ovary were longer than the anterior lobes. The full roe is of a deep orange colour.

Æglefinus.—The ripe roe is of a light orange colour; it is thick dorso-ventrally.

Poutassou.—In the small specimens the ovary showed as two little lobes close to the rectum. Fishes up to 17 cm. in length had a minute ovary. In the last case the ovary contained clear eggs measuring ·05 mm. in diameter.

XXIV. The Pyloric Cæca.

The cæca are small, very numerous, closely arranged in a mat—æglefinus, ogac, callarias, virens, pollachius.

Merlangus.—There is a large mass of cæca numbering from 33 to 90.

Poutassou.—The cæca were from 9 to 15 in number.

Argenteus.—The cæca were from 7 to 10 in number.

Saida.—The cæca were 24, 30, and 31 in number.

XXV. The Skeleton.

The skulls might be classified according to their length, but data are not at present available which would give the maximum size of the skull for each species. Any skull measuring 14 cm. in length may belong to the following species:—Callarias, ogac, virens, pollachius. The skulls of luscus, minutus, esmarki, argenteus, saida, probably never reach 10 cm. in length. The skull of whiting does reach and probably exceeds 10 cm. in length. One poutassou which I received on loan from Mr. Holt measured 37·9 cm. in length, and the skull probably measured between 8 and 9 cm. in length. The two specimens of this species described by Vinciguerra measured 35 cm. in length.

The Skulls, etc.—Callarias, virens, pollachius, Plates IV.–XI., *Twentieth Annual Report*; luscus, minutus, esmarki, Plate X., *Twenty-fourth Annual Report*; æglefinus, Plate II.; merlangus, ogac, poutassou, argenteus, saida, Plate III.

The differences between the skulls of the various species cannot be

readily reduced to words, and comparison must be made either on the skulls themselves or by means of drawings.

There is a certain number of characters by which the skulls may be roughly separated into groups.

Side View.—The first of these is—the shape of the ventral edge of the skull; that is, formed by the vomer, parasphenoid, and basi-occipital bones.

If the skull be laid resting on its ventral edge on a flat surface, so that the vomer, from which the teeth have been removed, is directly on the surface, it will be found that the next part of the edge to touch the surface will be:—(*a*) the basi-occipital, or (*b*) the hind half of the parasphenoid, or (*c*) the swollen opistholics projecting below the ventral edge.

To (*a*) belong callarias and ogac (fig. 15).

To (*b*) belong æglefinus, (fig. 11), merlangus (fig. 18), virens, pollachius, luscus, minutus, esmarki, poutassou (fig. 24), argenteus (fig. 26).

To (*c*) belongs saida (fig. 25).

The largest number of species, therefore, belong to division (*b*). In these skulls the basi-occipital is raised above the surface on which the skull rests. The extent to which it rises varies among the species, from the very slight elevation in merlangus to the very high upward bend in argenteus.

The opisthotics which form the cavities containing the otoliths are very varying in the part they play in the shape of the skull, and the differences may be referred to the following divisions, which are to be noted in a side view of the skull:—

The opisthotics do not extend down to the ventral edge of the skull in callarias, virens, pollachius.

They extend down closely to the ventral edge—æglefinus.

They extend down to the ventral edge of the skull—æglefinus, merlangus, luscus, esmarki, poutassou, [ogac ?].

They extend downwards beyond the parasphenoid; they project ventrally, in saida, argenteus.

A marked difference is found in the shape of the inter-orbital arch, the base of which is furnished by the parasphenoid, while its rim is formed by the pre-frontal, frontal, orbito-sphenoid, and pro-otic.

The arch is less than a semi-circle, *i.e.*, the length of its base is more than twice its height, in callarias, ogac, virens, pollachius, merlangus, saida, poutassou.

The arch is nearly a semi-circle in æglefinus and luscus.

The arch is a semi-circle in esmarki, minutus, argenteus.

The ethmoid slopes backwards much in virens, pollachius, saida, poutassou, argenteus, esmarki.

The anterior edge of the ethmoid is nearly vertical in callarias, ogac, æglefinus, merlangus, luscus, minutus.

There is a prominent notch in the front edge of the ethmoid in luscus, minutus, esmarki, argenteus.

A small notch is sometimes made out, but is sometimes absent—callarias, ogac, virens, pollachius.

The notch is absent—saida, poutassou.

The occipital spine rises high on the frontal bone in ogac, virens, pollachius, merlangus, minutus, esmarki, argenteus, æglefinus, and luscus. It is very high in the two last named.

The occipital spine does not rise off the frontal bone, but begins as a

thin verticle lamina on the parietal in saida; on the frontal it is merely a ridge. It rises, but is very low, on the frontal in callarias.

The hind end of the squamosal is very broad, its upper and lower edges are almost parallel, in æglefinus. The two edges approach one another rapidly as they proceed posteriorly in callarias, virens, pollachius, merlangus.

View from Above.

The shape of the frontal is of some importance. It tapers much at its anterior extremity in callarias, virens.

It is rounded in front in æglefinus (fig. 9), pollachius, merlangus (fig. 16), luscus, minutus, esmarki.

The middle foramina of the frontal are well separated from the anterior opening of the supra-orbital groove in callarias, ogac (fig. 19), æglefinus, virens, pollachius.

The foramina and the openings come close together in luscus, minutus, merlangus, poutassou (fig. 14), argenteus (fig. 20), saida (fig 13). They come very close together in the last species.

There are characteristic differences in the shape of the pre-frontals. As a rule their lateral edges slope backwards and outwards, *e.g.*, in callarias, ogac, æglefinus, virens, pollachius, poutassou.

In the following the pre-frontals project broadly from the side of the skull:—Luscus, minutus, esmarki, saida, argenteus. In argenteus the pre-frontals project anteriorly as broad plates (fig. 20).

The foramen of the *nervus lateralis* (*for.*, fig. 9) is associated with a projecting plate (*prc.*, *ib.*, fig. 16) of the parietal.

The plate covers the foramen: the plate is very large in pollachius, luscus.

The plate covers the foramen: the plate is a prominent process in callarias, merlangus.

The plate covers the foramen: the plate is long and comparatively narrow in minutus, esmarki, poutassou.

The plate covers the foramen: the plate is present as a very small ridge in saida.

The foramen is in front of (fig. 9) or on top of the process (fig. 19), which is very small, in æglefinus, ogac.

The ridge is absent in argenteus. The parietal is largely cartilaginous, and the foramen seems to pierce the parietal on top and anterior to the position usually occupied by the ridge in other Gadids.

In minutus the process was sometimes pierced on top by a foramen: the foramen of the *nervus lateralis* was covered by the process.

View from Below.

The opisthotics are swollen, rounded, with the parasphenoid depressed between them, in poutassou, saida, argenteus, minutus, esmarki.

The groove in the hind part of the parasphenoid, *i.e.*, between the articulations of that bone with the opisthotics, is very slight in virens, ogac.

The groove is well marked in æglefinus, merlangus, luscus, minutus, saida, esmarki, poutassou, argenteus.

The hind part of the parasphenoid is flat, or slightly convex, in callarias, pollachius.

Callarias and Ogac.

The skull of ogac which I was able to examine, was damaged in the occipital spine, squamosals, opisthotics, and ex-occipitals, but it was

nevertheless, sufficiently complete to show that the skull of this species differs distinctly from that of callarias.

Seen from above the frontal of ogac is a shorter and broader bone than that of callarias. In the latter it tapers much anteriorly. This relation accounts for the broad interorbital measurement on the head of ogac.

The foramen of the *nervus lateralis* is covered in callarias by the process of the parietal. In ogac the foramen is above and in front of the process.

The opisthotics in ogac appear to extend down to the ~~vertical~~ ventral line of the skull: they do not in callarias.

The vomer seems to be rather more pointed (view from above) in callarias than in ogac.

The occipital spine in ogac rises high on the frontal, whereas in callarias it is simply a ridge.

The skull of ogac is, I consider, on the whole shorter than that of callarias.

Diagnostic Value of other Bones.

Clavicle.—The clavicle of æglefinus is a characteristically solid bone (fig. 7). The post-clavicle of the same species is of a similar build (fig. 6). The clavicle and post-clavicle of merlangus are shown in figs. 22 and 28.

The skull and other head bones of æglefinus are well ossified.

Otoliths.—The otoliths of the Gadidæ and other fishes have been treated lately by Dr. T. Scott. I have therefore included here only five of the species, viz.:—Poutassou (fig. 21), argenteus (fig. 29), saida (fig. 30), ogac (fig. 23, after Vanhöffen), minutus (fig. 56).

In the case of the three species first discussed in this research, viz., callarias, virens, and pollachius, the comparison between them was carried out on all the bones of the head, and the result was to show that almost every bone had a greater or less specific character. The jaw bones are of much value in this respect. I have not continued this extended comparison of the skeleton. I publish here, however, drawings of an additional part of the skeleton of pollachius which, so far as I am aware, has not been published. The bones of the head of pollachius were figured in my paper in the *Twentieth Annual Report of the Fishery Board for Scotland*, Part III.

On the Diagnosis of Isolated Bones and Otoliths.

The presence of certain Gadoids in the stomachs of fishes and other animals has been detected by the otoliths which had resisted disintegration. An example of this is given by Scott, who found a large number of the earstones of merlangus in the stomach of a porpoise.

Jensen found in the bottom-deposits taken from the Polar Deep between Iceland and Jan Meyan, large numbers of the otoliths of poutassou, some of saida, and one each of callarias and virens.

There are also single bones, the specific identity of which can be recognised at once. For example, several of the bones of æglefinus are of this character, the clavicle and post-temporal being massive in comparison with those of other species.

It is, however, an advantage to have several bones of the fish upon which to work out the diagnosis.

I have on several occasions found on the shore of a small fresh-water

lake near Aberdeen, viz., Loch Loirston, little collections of bones. They were uninjured, but the skull bones were disarticulated. They had evidently been disgorged by some bird, probably a heron or a gull. They were sometimes stuck together in a bolus, which indicated, no doubt, that they had been disgorged a short time before. A similar bolus consisting of the husks of grain was noticed also.

The bones consist of the bones of the head, and one or two vertebræ. The vertebral column is absent.

One lot of bones consisted of those of merlangus. They were accompanied by whole and crushed shells of *Purpura lapillus*; the latter were stained purple. The bones were readily diagnosed by the otoliths, and by the fact that the following bones agreed with those of a type specimen, viz., dentary, mandible, and premaxilla.

The premaxilla was big in comparison with the other bones accompanying it. It was distinctly a Gadid bone. It had two rows of tooth-sockets, the outer very large, the inner very small. The latter tended to doubling near the head of the bone. The sockets extended over the bone almost to the tip. It was necessary to compare this bone with known premaxillæ of nearly the same size. It was compared in turn with the premaxillæ of callarias, pollachius, virens, æglefinus, luscus, minutus, merlangus. It agreed exactly with the latter.

One difficulty arises from the fact that the number of rows of teeth may vary with age. Thus in a pollachius measuring 36 cm. in length there were three rows of teeth on the broader part of the premaxilla, whereas as many as six rows could be made out on a big specimen, *e.g.*, 85 cm. long. Again, a callarias measuring 23·5 cm. had three or four rows of small teeth on the premaxilla, next the head of the bone, while an example 92 cm. long had six rows at least of small teeth in the corresponding place.

A second group of bones was found to consist of the bones of more than one æglefinus. The fishes were probably about 30 cm. in length. The characteristic heavy clavicle, supra-clavicle, and post-temporal were present. The premaxilla agreed with that bone taken from an æglefinus. The otoliths were present, but were not relied upon for diagnosis.

The Rib (Pleurapophysis) in Pollachius.

There are no ribs attached to the first and second vertebræ. The third, fourth, and fifth vertebræ bear stout ribs that have truncated ends. The first of these ribs (fig. 44) is the heaviest, the others getting gradually lighter. There are no transverse processes (parapophyses) on the third and fourth vertebræ, and the head of the rib fits into a hollow in the side of the centrum. The fifth vertebræ has a little transverse process, and as one proceeds along the vertebral column this process grows steadily bigger. The rib is anteriorly attached to the under surface of the parapophysis, but as the latter gets larger the rib is attached to the hind edge of its extremity. The ribs of the sixth* and seventh vertebræ are thinner and end in sharp points (*vide* fig. 45). Fig. 53 shows a rib situated further back on the vertebral column, and fig. 46 shows the shape of the head in different ribs.

The epipleural spines are attached to the ribs towards the head of the same.

* In one case the rib of the sixth vertebræ had a truncated end.

Distribution of the Gadidæ.

Hoek gives the distribution of the Gadidæ in northern waters in his catalogue of fishes of the North of Europe.

The Young Stages of the genus Gadus.

The young stages have been described by many authors. The subject has been comprehensively dealt with lately by Schmidt. He has described many stages of the following species:—Callarias, virens, pollachius, æglefinus, merlangus, luscus, minutus, poutassou, argenteus, esmarki.

The Stomach and the Gut.

The stomach is capable of great distension and extension. This is specially noticeable in virens. When gorged the stomach may extend well back into the hind abdomen. When the reproductive organs are large, however, they tend to prevent the full distension of the stomach.

The gut forms a loop in the hind part of the abdominal cavity. It goes backwards on the right side of the body and returns on the same side. The end of the loop is free in the cavity. Sometimes the loop goes round the end of the abdomen and extends forward for a little way on the left side (fig. 98). This condition was noted in some specimens of the following species:—Callarias, æglefinus, esmarki.

The Mesentery in Virens.

The mesentery is continuous with the peritoneum lining the posterior end of the abdominal cavity. It divides the hind abdomen longitudinally into two from the floor to the roof, binding the ureter to the hind lobes of the ovary and the latter to the roof of the cavity.

Proceeding anteriorly, it splits into two, giving a mesentery to each of the free anterior lobes of the ovary. Each lobe is thus supported separately to the roof of the abdomen. In front of the anus the mesentery is attached to the rectum at the beginning of the ovarian lobes, but anterior to this point it has no connection to the ventral surface. The spleen is supported by a median mesentery, and is often found lying between the lobes of the ovary.

Notes on the Species.

Callarias.—A prominent character in this fish is the broad fan-shaped tail fin. Its hind edge is convex. In the small cod the tail is slightly different in shape. In two specimens, 23 cm. and 38 cm. respectively, the hind edge was straight across. In two others, 25 cm. and 28 cm., there was a slight concavity in the hind edge.

The ureter left the kidney at the transverse process of the vertebra in front of the first hæmal arch.

The cod sometimes exhibits a small angle in the anterior edge of the orbit.

Æglefinus.—This species has a large eye and a small mouth.

In the large haddock, *e.g.*, from Iceland, the scales are large and the skin is tough and hard.

The barbel is stumpy, with a bulbous base.

The first dorsal fin has a characteristic shape in this species. It is

prolonged to an acute point. The longest ray was in 19 cases the second in one case it was the third ray. In one instance the second and third rays were of equal length. The fins have in the fresh condition a narrow white border.

Very little difference was noticed between the big Iceland haddocks and the haddocks obtained near the Scottish coasts. The eye of the large haddock is smaller in proportion than that of the small fish. Thus in the haddocks from 13–37 cm., the eye ranged from 6 to 8 per cent. of the length, whereas in the Iceland specimens, 72–84 cm. long, the eyes only reached 5–5·4 per cent. of the length. The eyes of the large Scottish haddocks, 56-61 cm. in length, occupied an intermediate position, viz., 5·3–6·2 per cent. of the length. The ventral fin was shorter in the large Scottish and Iceland specimens, viz., 9·8–10·8 and 9·8–11·6 per cent., than in the smaller Scottish fishes, where it measured 11·4–15·6 per cent. of the length. The Iceland fishes had a thicker root of tail and a greater spread of tail than the Scottish fish, measuring up to 37 cm. in length. In the other characters the fishes from the two regions were in agreement. The slight divergences noticed above may be simply differences due to age.

Merlangus.—Several writers have described merlangus as a Gadid in which there is no barbel. The barbel is, however, present. Steindacher found it in all the examples examined by him (Vinciguerra). I have found it in each specimen in which it was looked for. In a merlangus measuring 22 cm. in length the barbel measured 2 mm. Six large merlangus measuring 43–49 cm. were examined, and a very small white soft barbel was made out under the lens. It could just be detected in some cases, since it is so soft that it clings to the adjacent skin.

The ventral fin has a filamentous tip.

The anal fins sometimes unite (*vide* fig. 83). The last ray of the first anal fin is distinguished from the first ray of the second anal fin by the fact that the tip of the former is free, whereas the tip of the latter is buried in the tough skin which covers the front edge of the fin.

The caudal fin has a black margin. In fishes about 18 cm. long it is somewhat fanshaped. When the mouth is closed the upper jaw projects in front of the mandible, but when the mouth is open the mandible extends to the level of the premaxilla.

The longest ray of the first dorsal fin was noted in 16 cases. The third was the longest in 13 cases; in one fish it was the second. The third and fourth were equal in one instance, and in another the third, fourth, and fifth were equal. The unpaired fins have a narrow white margin.

Virens.—The lower jaw projects very much in large fishes. In the small fish of this species this character is not so prominent, and inexact examination may lead to the conclusion that the two jaws are of equal length. A number of small virens were examined to test this relationship. In 18 fishes measuring 20 to 30 cm. the lower jaw projected in front of the upper, in some by a little, in others more distinctly. One measuring 26 cm. in length appeared at first sight to have the two jaws of equal length, but examination showed that the lower just showed in front of the upper when the fish, with the mouth closed, was viewed from the dorsal side.

The eye in some virens is oval, with the long diameter vertical. A small angle in the anterior edge of the orbit is sometimes noticeable.

The little barbel is black.

Pollachius.—The eye in large pollachius (*e.g.*, 90 cm.) is distinctly oval in shape, both as regards the orbit and the lens also. The long axis of the oval was vertical

The ureter was found in one specimen to start from the kidney at the junction between the first and second vertebræ in front of the first hæmal arch.

Poutassou.—This species has no barbel. When the skin was removed from the dentaries, two small knobs were noticed in that region.

The tongue is spear-shaped. The wide gap between the second and third dorsal fins is characteristic.

The lateral line is nearly straight; it is inconspicuous in some specimens.

In one formaline specimen the skin was covered with minute black spots. In another there was an extensive dark axillary region. The snout was black. There appeared to be also a black pigment spot on the middle rays of the tail fin.

The black peritoneum sometimes shines through the abdominal wall in preserved specimens.

Gadus (*Gadiculus*) *argenteus.*—Guichenot separated this form from Gadus on account of the supposed absence of vomerine teeth in the former. Günther found, however, that the vomer does bear teeth. A skull measuring 3.6 cm. in length, from one of the present specimens, had very small teeth in the vomer.

It is a fragile form, and the specimens were much frayed. The skin had, as a rule, disappeared from the top of the head, exposing the cavities in the frontal bone, and the fin-rays were usually snapped off. There are therefore no data to show the relation in length between the pectoral and ventral fins. The pectoral fin was measured in four cases, but in no example was the ventral fin whole.

A double hook is present on the dentaries, one hook on each bone, in the region where the barbel is found in the Gadidæ.

The ureter leaves the kidney medianly just behind the end of the swim-bladder.

G. saida, Lepechin.—Vanhöffen obtained this species in quantity at Karajak, Greenland. He describes it as follows:—"In the upper half of the body it was of a brownish-grey colour, while the under-body had a silvery appearance. The skin was dotted with very small black pigment cells, which were at one time expanded into stellate chromatophores, at another were contracted to dots. The fins also showed a more or less broad dusky border, from which the black dusting extends along the fin-rays to their bases. The scales were circular and very small." The largest example found by Vanhöffen measured 22 cm. Jensen obtained two specimens measuring 25 and 26·7 cm. in length respectively. "Fabricius records one of a length of 35·6 cm."

Vanhöffen institutes a comparison between saida and pollachius, virens and minutus. "Minutus resembles saida in its colour, even to the indication of a black spot on the base of the pectoral fin. The main distinguishing features of saida are the small number of rays on the first anal fin and the narrower root to the tail. Moreover, the form of the otolith seems characteristic. Saida is distributed over the whole North Polar Sea, in East and West Greenland, Spitzbergen, Barents Sea, Behring Sea, and on the coasts of Labrador." It is also found at Iceland (Schmidt).

The barbel is very small.

The membrane of the fins is thin, and the fin-rays are weak.

The tail is broad dorso-ventrally.

The head has great depth; the mouth is very large.

The lateral line is made out with difficulty by means of the small detached scutes. It follows a sinuous course; starting above the oper-

cular cleft, it passes backwards in a gentle curve to cross the lateral axis about the beginning of the second dorsal fin. It continues its course below the lateral axis either in a single curve or in several smaller curves, to rise again to the axis near the beginning of the third dorsal fin, and to run straight backwards to the tail. The part below the lateral axis sometimes varies on the two sides of the fish.

The skin of the preserved fish had a golden sheen.

The ureter left the kidney at the first hæmal arch. It was in the mesentery between the two hind lobes of the testis.

The ovary was yellow in colour.

The testes in one specimen measuring 16·8 cm. were very large; they filled up practically the whole of the abdominal cavity (fig. 88 T).

Jensen obtained small specimens of this species in Greenland. Two post-larval fishes measured 13·5 and 16 mm. in length. They were captured in August. A quantity of fry measuring 45–74 mm. was obtained in the same month. One, 45 mm. long, "is pigmented on back and flanks with dark cross-formed or stellate chromatophores. In the larger young ones the dark chromatophores are sometimes massed in some places towards the back, and produce an intimation of transverse bands; the distal margins of the dorsal fins, and partly also of the anal fins, are frequently strongly pigmented."

Gadus ogac, Richardson. Fig. 1. Plate I. Fig. 13a.—Vanhöffen had the opportunity of examining this species in the fresh condition in Greenland. He discusses it as follows:—

"*Gadus ovac*, Reinhardt, is only a dark-coloured variety of *Gadus morrhua*, occurring on the coasts of Greenland. Both of these species are got there. The near relationship of ovac and morrhua is seen in the number of the fin-rays and in the structure of the otoliths (fig. 23), as well as in the body measurements, which in some respects approach æglefinus. According to Dresel, ovac and morrhua from the Greenland and American coasts differ, in addition to colour, in the following respects:—In ovac the tail is narrower, the eye is larger, the interorbital space more prominent, the barbel longer, the ventral fin is placed further forward, and the pectoral fin is longer than in morrhua. Lütken distinguished them by the following characters:—Ovac has a plumper form, thicker head, and broader forehead. The upper jaw does not extend so far forward, and it reaches further back than in morrhua. The unpaired fins are higher and more rounded in ovac. The lateral line is not distinct, and the body is of a dark colour without clear spots." Vanhöffen maintained that of these characters only the following remained of moment, viz., the greater breadth of the forehead, the length of the barbel, and the different colour of the body. He dismissed the character founded on the length of the barbel, and pointed out that the form of the head changes in fishes with age, or season, or habits, while colour was generally recognised as one of the most uncertain characters. Summing up, he could not agree with Lütken, who insists on ovac as a separate species; but from the present state of knowledge, must agree with Günther in regarding it as a variety of *G. morrhua*. Ovac has been recorded from the West Coast of Greenland, from Iceland, and Scotland (Günther).

I have had the privilege of examining one of Vanhöffen's specimens, and also one from the Copenhagen Museum. I am of the opinion that ogac is a good species. It is not possible to get a satisfactory specific description from two specimens, and I am not, therefore, inclined to put too much emphasis on the body characters which have been already selected, although I am disposed to regard them as valid.

There are two characters which have not so far been mentioned. One of these is the shape of the skull (figs. 15 and 19 and page 122), which is very distinct from that of callarias, and the second is the presence of black pigment on the external wall of the ovary (fig. 76, *ov.*), and also inside that organ. I have not, so far, noticed black pigment in the ovary of any other Gadid. This ovary of ogac contained small yolked eggs measuring ·3 mm. in diameter, large yolked eggs ·65 mm. in diameter, and clear eggs ·05–·2 mm. in diameter.

As Vanhöffen pointed out, ogac comes very near callarias in the number of fin-rays in the unpaired fins, but a similar relationship exists between other Gadids, *e.g.*, virens and pollachius, luscus and minutus. The following are certain points which were prominent in this fish (figs. 21 and 13a) :—The barbel is long, stout on one example. The lateral line has a bend that is not very pronounced; it meets the lateral axis about the first half of the second dorsal. The skin is of a uniform dark brown all over. The peritoneum is very dark. There is an external anal tube (fig. 13a) in one example. The ureter opens to the exterior by a small median aperture close behind the wide genital opening. The tail fin is slightly concave on its hind edge. The abdominal cavity extends back to about the middle of the first anal fin (fig. 76). The piebald colour of the ovary is noteworthy (fig. 76). The inside of the mouth is brown-coloured.

The specimen belonging to the Copenhagen Museum was much smaller. It measured 33·5 cm. in length. It is shown reduced in Plate VII. The hind margin of the tail is distinctly concave, with the rami of the tail rounded. The forehead is flattish. The barbel is long, and not very stout. There is no distinct anal tube, although there is a raised border round the anas, and there is a fairly long genital tube projecting. The lower jaw is very little short of the upper when the mouth is closed.

The fish is of a laminarian colour all over; the abdomen is of a lighter shade of the same colour. The scales are brownish-tinted, transparent, except at the exposed part, where there is a patch of dark brown pigment. The rings of growth on the scales are well marked. The lateral line is continuous, except from the middle of the third dorsal backwards, where the scutes are separate. Both ogac and callarias have the sensory processes, possessed by other Gadids, on the inside of both lips. The pits on the skin of the mandible are common to other species of Gadus in addition to ogac and callarias. No difference was made out in the teeth between the two species.

Gadus navaga is a small species. Its specific characters are given by Günther as follows :—

Barbel small; shorter than the eye, the diameter of which is somewhat less than the width of the inter-orbital space and one-half of the length of the snout. The snout is sub-conical, obtuse, with the upper jaw the longer. The height of the body is less than the length of the head, which is one-fourth of the total (without caudal). The vent is situated vertically below the origin of the second dorsal. Tail very slender, fins separated by interspaces from one another. Caudal fin truncated. Colour, brownish with reticulated dark lines on the back.

Size—Seven to nine inches long—White Sea.

Kölreuter says that the colour is brown over the dorsum without spots. The swim-bladder has two horns.

The specimen kindly lent by Dr. Jungersen was obtained in Greenland (fig. 84). In general colouring it was not unlike a small cod that had been preserved in alcohol. It has a little stumpy barbel with a fine tip, nearly resembling that of æglefinus. The tail fin was damaged, one

ramus only being present. Smitt says that the concavity in the hin edge of the tail fin is greater in this species than in ogac.

There is a small external genital papilla. The head resembles that of merlangus. The growth rings on the scales are well marked. The lateral line is composed of separate scutes behind the beginning of the second dorsal fin.

The Specific Identity of a Fish.

The specific identity is not merely the possession of certain external characters, or a matter of certain distances measured on the surface of the body. It extends through the whole of the organism, exhibiting itself in the skeleton, the abdominal cavity and its organs, and in the appearance, edible quality, and flavour of the flesh. The habits of each species, when they are thoroughly known, will probably be found to be very distinct, the mode of life, food, etc., all serving to distinguish one species from another. In a genus all the species will overlap in their modes of life, just as they do in their bodily characters, but in the aggregate of their habits they will be as clearly identified as in their external form and appearance.

LITERATURE.

Books, St. John.—"The Osteology and Arthrology of the Haddock (*Gadus æglefinus*). *The Scientific Proceedings of the the Dublin Royal Society* [Read 1893.]

Cunningham.—"Marketable Marine Fishes." London, 1896.

Day.—"The Fishes of Great Britain and Ireland." London, 1880-1884.

Fulton.—"Ichthyological Notes." [*Gadus argenteus, G. poutassou.*] *Nineteenth Annual Report of the Fishery Board for Scotland* for 1900 (1901), Pt. III., p. 284.

——— "Ichthyological Notes." [*Gadus* (*Gadiculus*) *argenteus* occurring ten miles off Aberdeen.] *Twentieth Annual Report of the Fishery Board for Scotland* for 1901 (1902), Pt. III., p. 539.

Günther.—"Catalogue of the Acanthopterygii Pharyngognathi et Anacanthini in the Collection of the British Museum." London, 1862. Vol. IV.

——— "Notes on some Fishes obtained at considerable depths in the North Atlantic." *Ann. and Mag. Nat. Hist.* (4). Vol. XIII., 1874, p. 138 [*Gadus argenteus*, etc.].

Hoek.—"Catalogue des Poissons du Nord de l'Europe, avec les Noms vulgaires dont on se sert dans les Langues de cette Region." *Conseil permanent International peur l'Exploration de la Mer. Publications de Circonstance*, No. 12. Copenhagen, May, 1904. [Distribution.]

Holt and Calderwood.—"Survey of Fishing-Grounds, West Coast of Ireland, 1890-1891. Report on the Rarer Fishes" (Pl XXXIX. to XLIV.). *Scientific Transactions of the Dublin Royal Society.* Vol. V. (II), 1893-1896, p. 361 [*Gadus poutassou, G. esmarki, G. argenteus*].

Jensen, Ad. S.—"The Fishes of East Greenland." *Meddelser om Grönland*, Vol. XXIX. Copenhagen, 1904. [Contains notes on *Gadus ogac* and *Gadus saida*, and description of the young of *saida*.]

——— "I. Otoliths of the *Gadus* species deposited in the Polar Deep." *Meddelser fra Kommissionen for Havundersögelser.* Serie, Fiskerie. Bd. I., Na. 7. Copenhagen, 1905. [Otoliths of *G. poutassou, saida, callarias, and virens.*]

Johnstone, J.—"The Food of Fishes." No. XV. *Report for 1906 from the Lancashire Sea-Fisheries Laboratory, University of Liverpool, and the Sea-Fish Hatchery at Piel.* Liverpool, 1907, p. 216. [Includes the food of *Gadus callarias*].

Kölreuter.—"Descriptio piscis e Gadorum genere russis Nawaga dicti, historico anatomica." *Novi Commentarii Academiæ Scientiarum Imperialis Petropolitanæ.* Tom. XIV., pro anno 1759. Petropoli, 1770. [Specific description and figure of *G. navaga.*]

Lepechin.—"Descriptio piscis e Gadorum genere russis Saida dicti." *Novi Commentarii Academiæ Scientiarum Imperialis Petropolitanæ.* Tom. XVII., pro anno 1773. Petropoli, 1774. [Specific description and figure of *G. saida*].

M'Intosh.—"On the Life-histories of the Cod, Haddock, and Whiting." *Fifteenth Annual Report of the Fishery Board for Scotland* for 1896, Pt. III., p. 194. 1897.

——— "Report upon a series of Observations upon the result of the use of the Beam Trawl-net and the destruction of Food-fishes off the East Coast of Scotland from January to August, 1884, with a register of the contents of the haul of each Net." *Appendix* to the Report of the Trawling Commission, 1885. [Food of Gadidæ, etc.] Blue Book. [C. 4324.] 1885.

M'Intosh and Masterman.—"The Life-histories of the British Marine Food-fishes." London, 1897.

Möbius, u. Heincke.—"Die Fische der Ostsee." Berlin, 1883.

Owen.—"Hunterian Lectures. II. Lectures on the Comparative Anatomy and Physiology of the Vertebrate Animals. Pt. I., Fishes." London, 1846. [Skeleton of *G. callarias*, *æglefinus*, etc.]

Parnell.—"Fishes of the Firth of Forth." Edinburgh. 1838.

Scandinavian Fishes.—(By Fries, Ekström, Sandevall, Wright, and Smitt.) Stockholm, 1893.

Schmidt.—"The Pelagic Post-larval Stages of the Atlantic species of *Gadus*. A Monograph, Pt. II." *Meddelser fra Kommissionen for Havundersögelser.* Fiskeri, Bd. II. Copenhagen, 1906. [Young stages of *G. callarias*, *æglefinus*, *merlangus*, *luscus*, *minutus*, *argenteus*, *poutassou*]

Scott, A.—"Notes on the Food of Young Fishes." No. XV. *Report for 1906 from the Lancashire Sea-Fisheries Laboratory, University of Liverpool, and the Sea-Fish Hatchery at Piel.* Liverpool, 1907, p. 99. [Food of post-larval Gadoids.]

Scott, T.—"On a Large Haddock." *Sixth Annual Report of the Fishery Board for Scotland*, 1888. [The haddock was captured in the Clyde and measured 31 inches (77 cm.) in length.]

——— "Observations on the Food of Fishes." *Twentieth Annual Report of the Fishery Board for Scotland*, for 1901. Pt. III., 1902. [Food of Gadidæ, etc., Otoliths of *G. callarias*, *æglefinus*, *merlangus*, *pollachius*.]

——— "Some further Observations on the Food of Fishes, with a note on the Food observed in the stomach of a common Porpoise." *Twenty-first Annual Report of the Fishery Board for Scotland*, for 1902. Pt. III., 1903. [Otoliths of *G. merlangus*.]

——— "Observations on the Otoliths of some Teleostean Fishes." *Twenty-fourth Annual Report of the Fishery Board for Scotland*, for 1905. Pt. III., 1906. [Otoliths of *G. callarias*, *æglefinus*, *merlangus*, *pollachius*, *luscus*, *poutassou*, *esmarki*.]

Todd, R. A.—"Report on the Food of Fishes collected during 1903." *International Investigations, Marine Biological Association, Report I.*, 1902-1903. London, 1905. Pp. 227 *et seq.* [Food of the Gadidæ, etc.]

Vanhöffen.—"Grönland—Expedition der Gesellschaft für Erdkunde zu Berlin, 1891-1893." 2 ter Band. 1 Theil. Berlin, 1897. [Description of *G. saida* and *G. ovac.*]

Vinciguerra.—"Risultati ittiologici delle Crociere del Violante—*Gadus poutassou.*" Genova, 1883. [Specific description with figure.]

Williamson, H. C.—"A Comparison between the Cod (*Gadus callarias*, Linn.), the Saithe (*Gadus virens*, Linn.), and the Lythe (*Gadus pollachius*, Linn.) in respect to certain external and osteological characters." *Twentieth Annual Report of the Fishery Board for Scotland* for the year 1901. Pt. III., pp. 228 *et seq.* 1902.

——— "On the Specific Characters of *Gadus luscus*, *G. minutus*, *G. esmarki*." *Twenty-fourth Annual Report of the Fishery Board for Scotland* for the year 1905. Pt. III., pp. 116 *et seq.* 1906.

Yarrell.—"A History of the British Fishes." London, 1861.

EXPLANATION OF THE LETTERS USED IN THE PLATES

a.—Anus.
At.—Atlas Vertebra.
1 a.—First anal fin.
2 a.—Second anal fin.
b Oc.—Basi-occipital.
bl.—Bladder.
br.—Broken edge of bone (figs. 15 and 19).
c.—Centrum of Vertrebra.
cæ.—Cæca.
Cl.—Clavicle.
E.—Ethmoid.
e Oc.—Ex-occipital.
F.—Frontal.
f.—Pseudo hæmal arch (fig. 74).
for.—Foramen.
ft.—Fibrous tissue.
g.—Gut.

EXPLANATION OF THE LETTERS USED IN THE PLATES—*Continued.*

g. ap.—Genital aperture.
g. p.—Genital papilla.
h k.—Head kidney.
hp.—Hæmapophysis (side of hæmal arch).
hs.—Hæmal spine.
1 h.—First hæmal arch.
in. sp.—Interspinous bones
k.—Kidney.
l.—Liver.
m.—Muscle.
me.—Mesentery.
np.—Neurapophysis.
ns.—Neural spine.
Oc. Sp.—Occipital spine.
op. O.—Opisthotic.
Or. S.—Orbito-sphenoid.
Ot.—Otolith.
ov.—Ovary, oviduct.
P.—Parietal.
par. Oc.—Par-occipital.
pl.—Pleurapophysis.
pp.—Parapophysis (transverse process of Vertebra).
prc.—Process (of a bone).
pr. F.—Pre-frontal.
pr. O.—Pro-otic.
p. S.—Para-sphenoid.
pt. Cl.—Post-clavicle.
pt. F.—Post-frontal.
rct.—Rectum.
s. Oc.—Supra-occipital.
s. Or.—Anterior opening of supra-orbital groove.
Sq.—Squamosal.
st.—Stomach.
sw. bl.—Swim-bladder.
t.—Testis.
ur.—Ureter, urinary.
V.—Vomer.
Vert.—Vertebra.
Zyp.—Zygapophysis.

EXPLANATION OF PLATES.

DIAGRAM.

Gadus merlangus, to show Measurement—Characters. *See* p. 99.

PLATE VIII.

FIG. 1. *Gadus ogac.*
,, 3. ,, *saida.* × $\frac{5}{6}$
,, 2. ,, *argenteus.* × $\frac{5}{6}$ Imperfect specimen.
,, 4. ,, *poutassou*, reduced. Natural size was 16 cm. in length.

PLATE IX.

FIG. 6. Post-clavicle of *G. æglefinus.* Iceland. *Nat. size.*
,, 7. Clavicle of *G. æglefinus.* Iceland. *Nat. size.*
,, 8. Skull, view from below, *G. æglefinus.* Iceland. *Nat. size.*
,, 9. ,, ,, ,, above, ,, ,, ,,
,, 10. ,, ,, ,, behind, ,, ,, ,,
,, 11. ,, ,, ,, side, ,, ,, ,,

PLATE X.

FIG. 12. Skull of *G. saida*, from above. *Nat. size.*
,, 13. Ovary of *G. virens*, 92 cm. long. September 1908. × $\frac{1}{2}$. Eggs measure ·22 mm.
,, 13A. *G. ogac.* Greenland. × $\frac{1}{3}$. Anal region to show anal tube (*a*).
,, 14. Skull of *G. poutassou*, 17 cm. long, from above. *Nat. size.*
,, 15. ,, *G. ogac*, from the side. *Nat. size.*
,, 16. ,, *G. merlangus*, from above. *Nat. size.*
,, 17. ,, ,, ,, behind. ,,
,, 18. ,, ,, ,, the side. ,,
,, 19. ,, *G. ogac*, from above. *Nat. size.*
,, 20. ,, *G. argenteus*, from above. *Nat. size.*
,, 21. Otolith of *G. poutassou*, two views. Natural size. Fish 16 cm. total length.
,, 22. Post-clavicle of *G. merlangus.* *Nat. size.*
,, 23. Otolith, two sides, *G. ovac*, 67 cm. long. *Nat. size.* After Vanhöffen.
,, 24. Skull of *G. poutassou*, from side. *Nat. size.*
,, 25. ,, *G. saida*, from side. *Nat. size.*
,, 26. ,, *G. argenteus*, 14·6 cm., from side. *Nat. size,*
,, 27. ,, *G. merlangus*, from below. *Nat. size.*

Fig. 28. Clavicle of *G. merlangus*. *Nat. size.*
,, 29. Otolith of *G. argenteus*, right side. *Nat. size.* Sharp end posterior. *o* outer side, *i* inner side. There is a ridge along the centre.
,, 30. Otolith of *G. saida*. *Nat. size.*
,, 31. Vomer of *G. poutassou*, from in front.

PLATE XI.

Figs. 32–55 are of *Gadus pollachius*, 87·8 cm. long.
Fig. 32. Atlas vertebra seen from the side next the skull. *Nat. size.* *x*—part that articulates with the basioccipital; *y*—part that articulates with the ex-occipital.
,, 33. Eleventh vertebra, posterior end. *Nat. size.* The small processes, *prc.*, on the edge of the centrum unite eventually with the posterior element of the parapophysis (transverse process). They are present on the vertebra bearing the first hæmal arch (viz., the twenty-second vertebra), but have disappeared on the twenty-fifth vertebra.
,, 34. The first eleven vertebræ. × ½ *c*—centrum; *pp*—parapophysis.
,, 35. Pectoral fin-ray. *Nat. size.*
,, 36. First dorsal fin-ray seen from the posterior side. *Nat. size.* *h*—small hemispherical articular processes between the two half-rays.
,, 37. Seventh ray of first dorsal fin. *Nat. size.* Side view.
,, 38. Vertebræ, 12 to 26, × ½. *Zyp*—zygapophysis.
,, 39. Twenty-second vertebra, bearing the first hæmal arch. *Nat. size.* Posterior surface. *Hp*—hæmapophysis.
,, 40. Vertebræ, 27–53, × ½.
,, 41. Interspinous bone of third dorsal fin. *Nat. size.* *Pt*—protuberance.
,, 42. First eleven vertebræ, ventral view. × ½.
Fig. 43. Fifth vertebra, showing the end next the skull. *Nat. size.* *ns*—neural spine; *np*—neurapophysis; *pp*—parapophysis; *pl*—pleurapophysis.
,, 44. First rib (*i.e.*, attached to the third vertebra). *Nat. size.*
,, 45. Rib attached to the sixth vertebra (?) *Nat. size.*
,, 46. Heads of ribs. Enlarged a little.
,, 47. Caudal fin-ray. *Nat. size.*
,, 48. ,, ,, ,, Left side; *lh*—left half; *rh*—right half.
,, 49. ,, ,, dorsal view. *Nat. size.*
,, 50. Half of a caudal fin-ray, showing the surface that is in contact with the other half-ray. *Nat. size.* *u*—unsegmented strip; *s*—segmented intermediate portion.
,, 51. Base of caudal fin-rays. Ventral view. *Nat. size.*
,, 52. Basi-branchials, seen from above.
,, 53. One of the ribs attached to the seventh to twenty-first vertebræ. *Nat. size.*
,, 54. Eleventh vertebra, seen from above. *Nat. size.* The neurapophysis is formed in part of cancellous tissue. The pores are large and perforate the bone.
,, 55. Interspinous bones of the first dorsal fin.
,, 56. Otolith of *G. minutus*, 23 cm. long. *Nat. size.*
,, 57. First hæmal arch of *G. poutassou*, 13·7 cm. long. *Nat. size.*
,, 58. ,, ,, ,, *G. argenteus*. *Nat size.*
,, 59. ,, ,, ,, *G. saida*. *Nat. size.*
,, 60. Hind abdominal cavity of *G. saida*. *Nat. size.*
,, 61. First hæmal arch of *G. callarias*, 38·8 cm. *Nat. size.*
,, 62. Hind abdominal cavity of *G. merlangus*, 38·5 cm.
,, 63. First hæmal arch of *G. minutus*, 21·7 cm. *Nat. size.*
,, 64. ,, ,, ,, *G. esmarki*, 19·5 cm. ,,
,, 65. ,, ,, ,, *G. merlangus*, 38·5 cm. ,,
,, 66. ,, ,, ,, *G. virens*, 53 cm. ,,
,, 67. ,, ,, ,, *G. luscus*, 27·5 cm. ,,
,, 68. ,, ,, ,, *G. æglefinus*, 36 cm. ,,

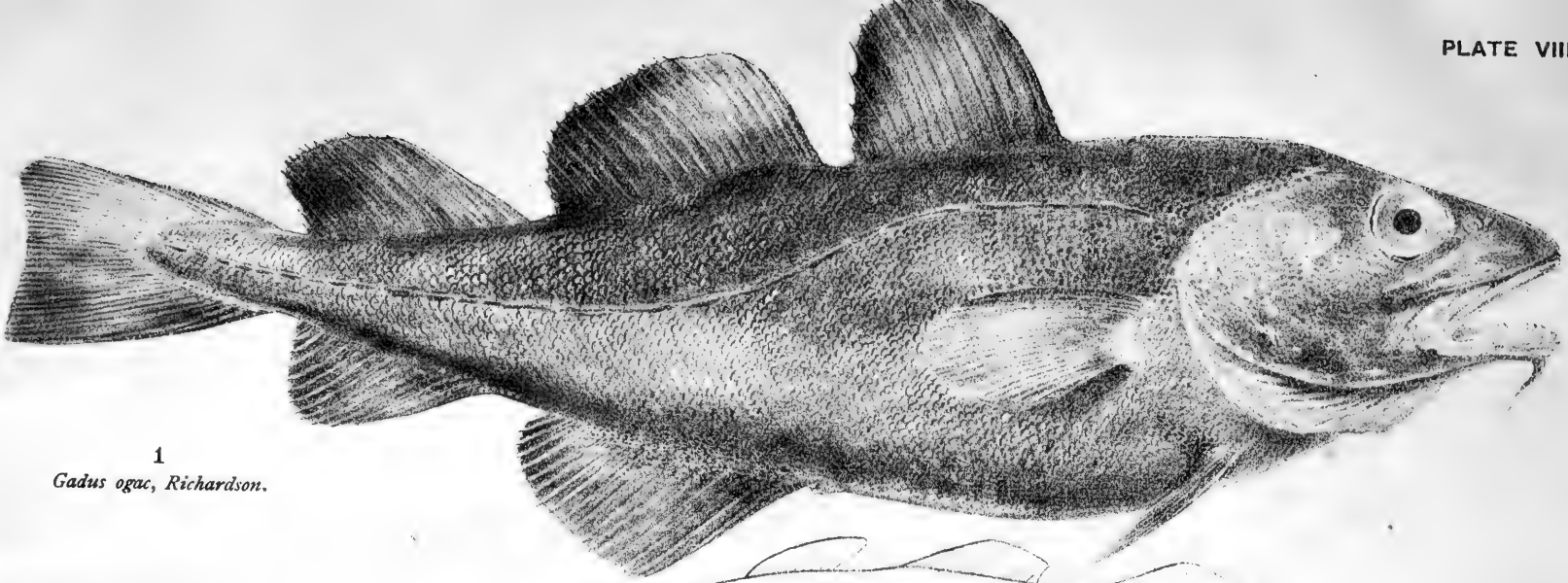
PLATE XII.

Fig. 69. Hind abdominal cavity of *G. argenteus*. *About nat. size.*
,, 70. ,, ,, ,, *G. poutassou*, 13·7 cm. long. Reduced.
,, 71. Abdominal cavity of *G. luscus*, 27·5 cm. long. Reduced.
,, 72. ,, ,, *G. pollachius*, 93 cm. long. Reduced. The dotted line indicates the course of the ureter on the right side of the body.

FIG. 73 Ovary of *G. luscus*, 27·5 cm. long. Reduced.
,, 74. Abdominal cavity of *G. virens*, 55·4 cm. long. Reduced.
,, 75. ,, ,, *G. esmarki*, 15·7 cm. long. ,,
,, 76. ,, ,, *G. ogac.* × ½.
,, 77. Ovary of *G. minutus*. Reduced.
,, 78. ,, *G. saida*, 17·5 cm. long. *Nat. size.*
,, 79. ,, *G. merlangus*. Reduced.
,, 80. Hind abdominal cavity of *G. minutus*, 26·5 cm. *Nat. size.*
,, 81. ,, ,, ,, *G. æglefinus*, 36 cm.
,, 82. Ovary of *G. merlangus*, 36·4 cm. long. Side view.
,, 83. Junction of first and second anal fins of *G. merlangus*, 36·4 cm. long.

PLATE XIII.

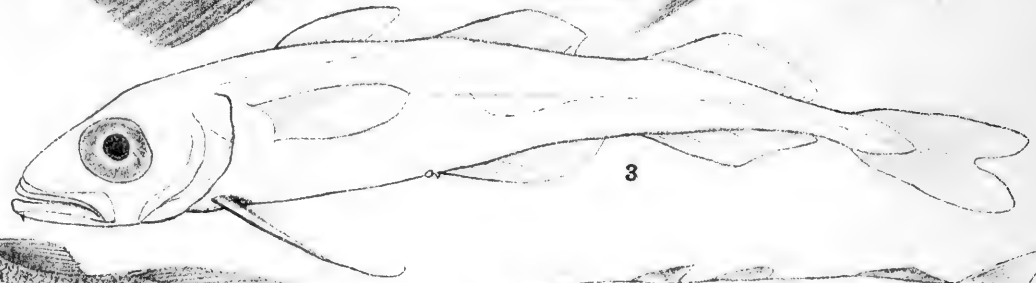
FIG. 84. *G. navaga. Nat. size.*
,, 85. Anterior end of swim-bladder of *G. pollachius*, 50·5 cm. long.
,, 86. Abdomen opened to show ovary, etc., of *G. esmarki.*
,, 87. Ovary of *G. æglefinus.* View from above.
,, 88. Abdomen of *G. saida*, opened to show large testis—*t. Nat. size.*
,, 89. Loop of gut at end of abdomen of *G. pollachius*, 76 cm. long.
,, 90. Ovary of *G. callarias.* × ½.
,, 91. Hind abdominal cavity of *G. callarias*, 69 cm. long. Reduced.
,, 92. Ovary of *G. argenteus*, 17·4 cm. long. *About nat. size.*
,, 93. Anterior end of the swim-bladder of *G. callarias.*
,, 94. Ovary of *G. pollachius*, 80 cm. long. Side view. × about ½.
,, 95. Anterior end of the swim-bladder of *G. merlangus.*
,, 96. Ovary of *G. pollachius.* Same as Fig. 94. View from below.
,, 97. Ovary of *G. esmarki*, 19·5 cm. long. *About nat. size.*



1

Gadus ogac, Richardson.

2



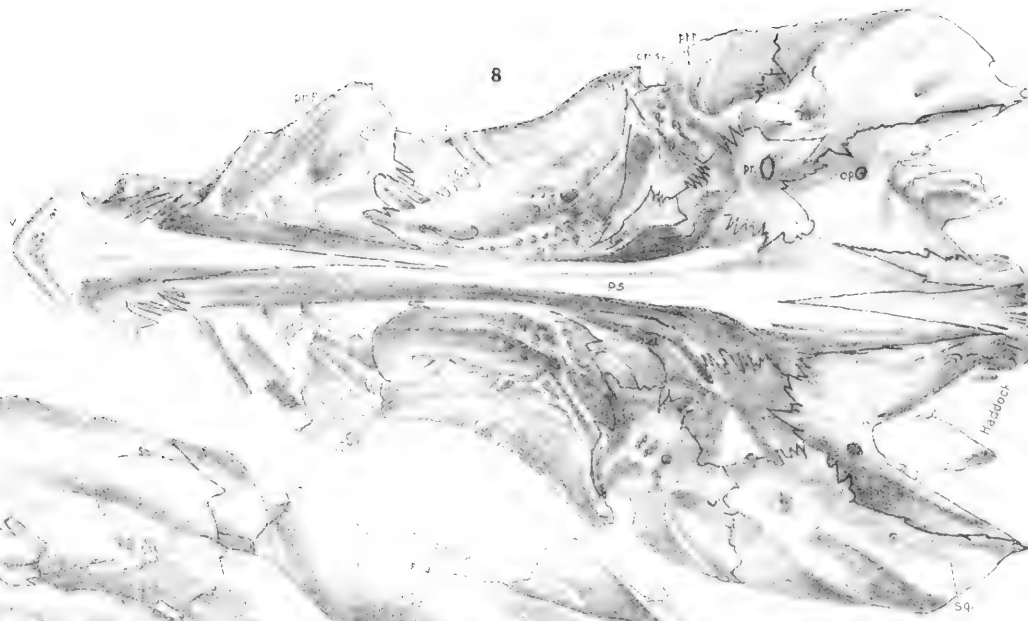
3

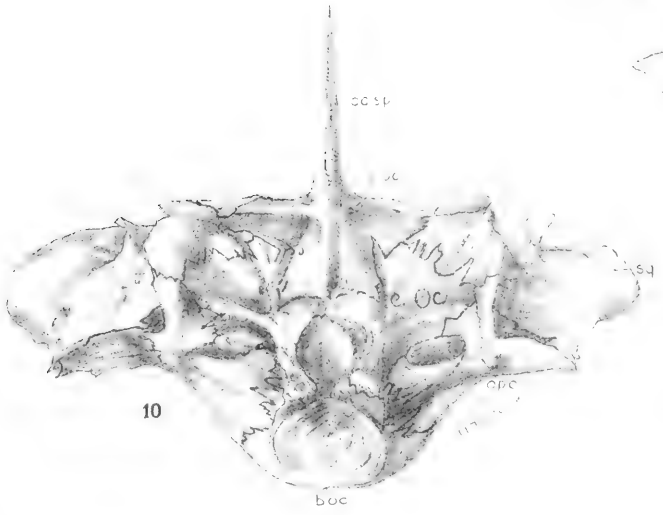
4

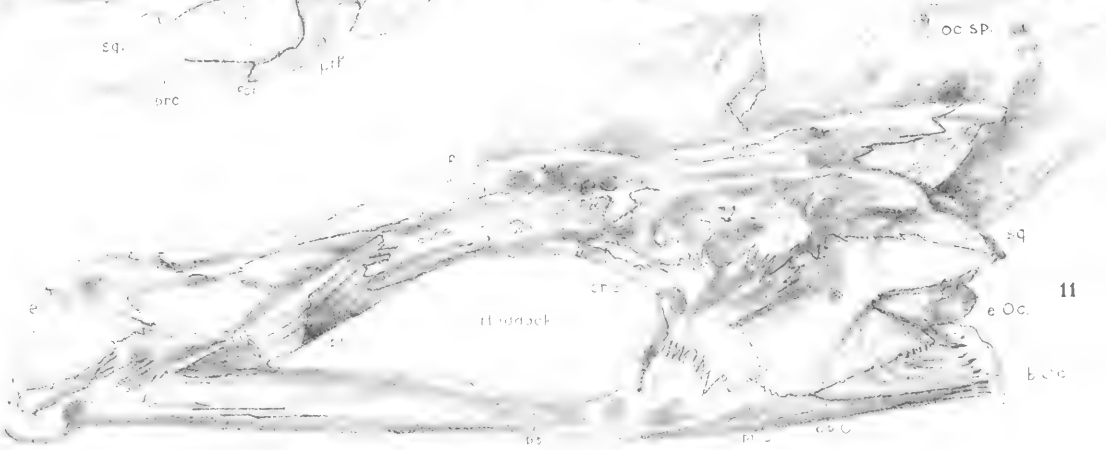
FIG. 1, A. H. WALKER.

FIGS. 2, 3, 4, H.C.W.

Gadus Sp.

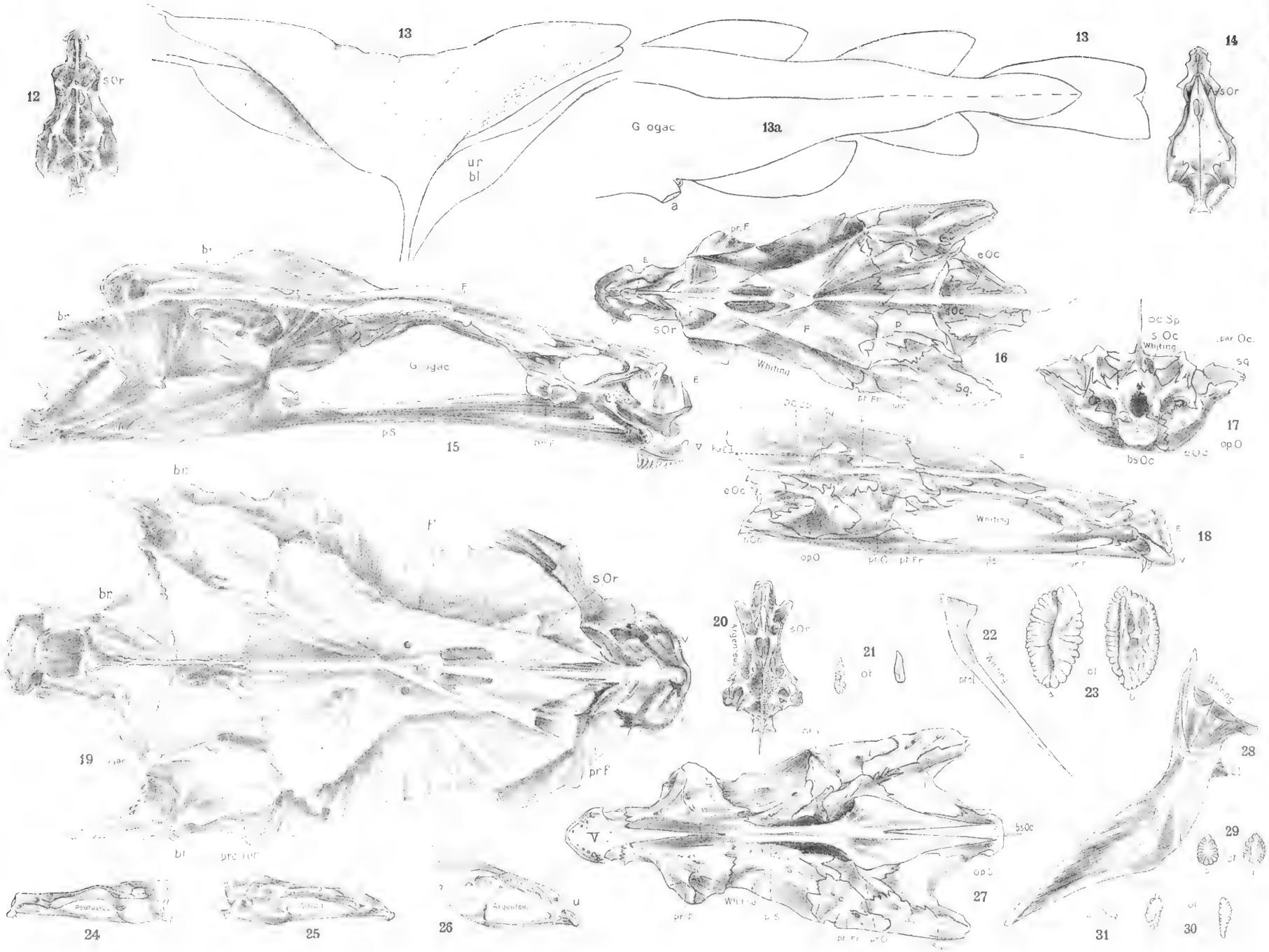






A. H. Walker.

Gadus æglefinus.



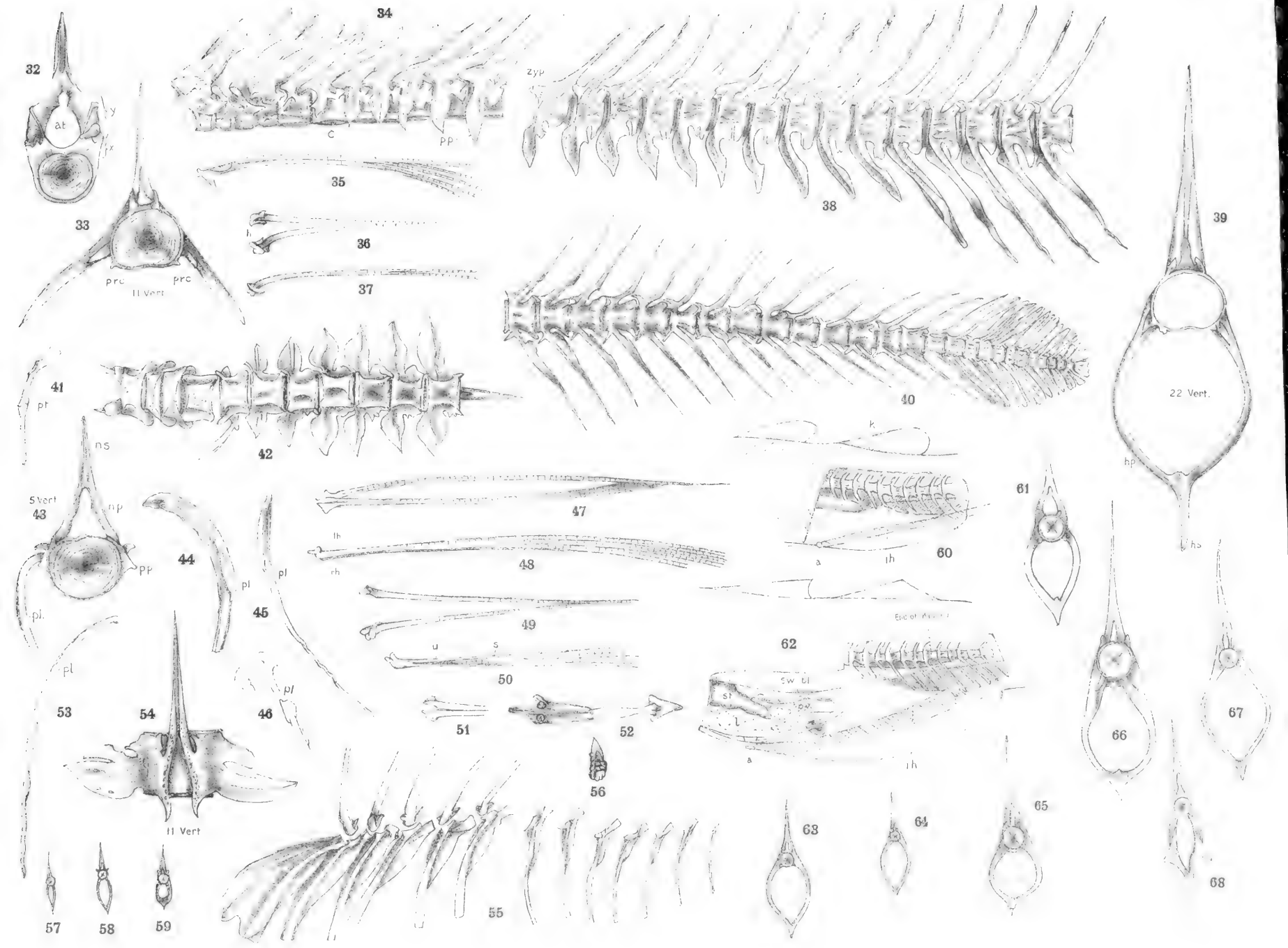
A. H. Walker.

H.C.W., Figs. 13, 13a, 14, 21, 24, 29, 30, 31;

Fig. 23, after Vanhöffen;

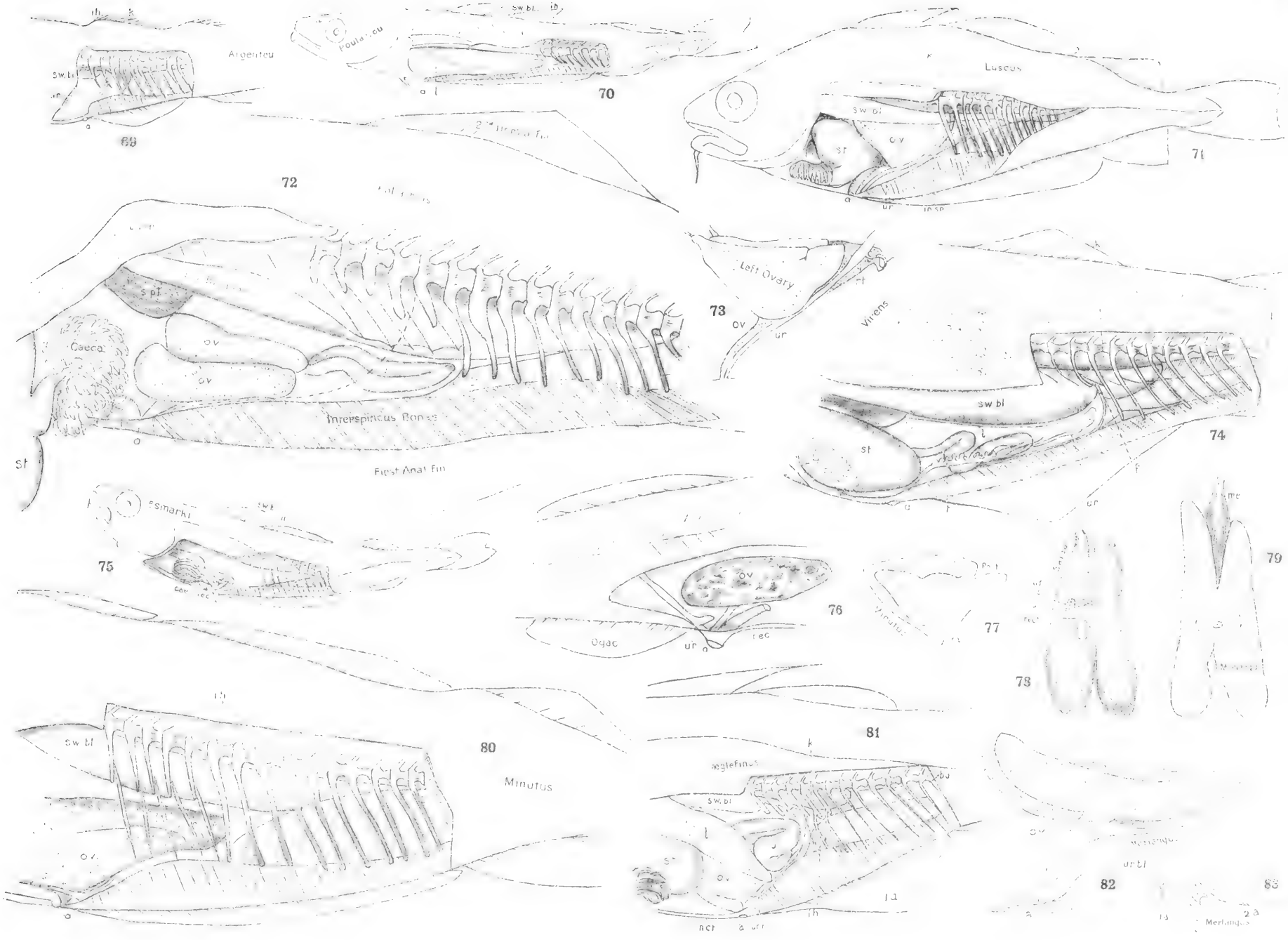
Figs. 16, 17, 18, 22, 27, 28, *Gadus Merlangus*; Figs. 12, 15, 19, 23, *G. ogac*;

Figs. 13, 25, 30, *G. saida*; Figs. 14, 21, 24, 31, *G. Poutassou*; Figs. 20, 26, 29, *C. argenteus*.



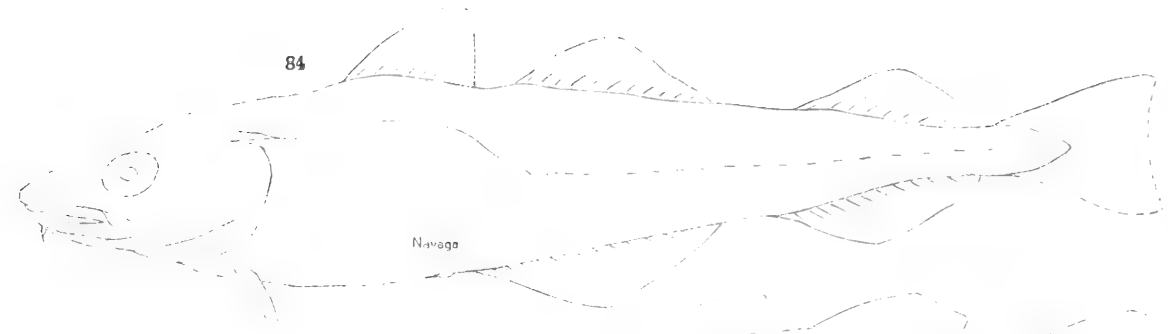
H.C.W.

FIGS. 32–55, *Gadus Pollachius*, 87·8 CM.; FIGS. 56–68, *Gadus Sp.*


Argenteu
69
70
Luscus
71
72
Left Ovary
73
Virens
74
Caeca
Interspinous Bones
First Anal Fin
75
Esmarki
76
Ovae
77
78
79
Minutus
80
81
82
83

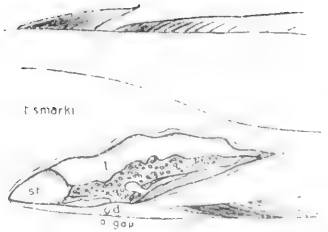
H.C.W.

Gadus Sp.

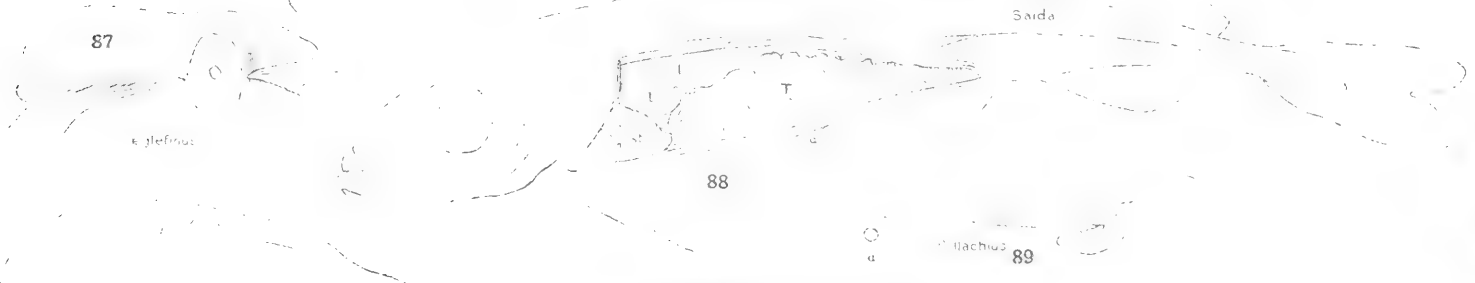


84

85



86

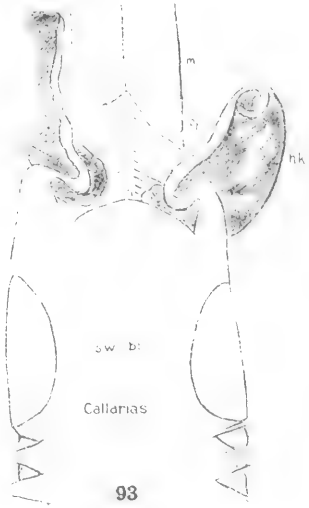


87

88

89

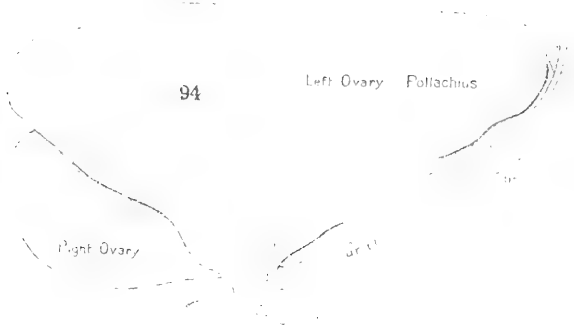
92



93

90

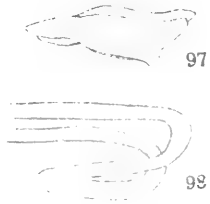
91



94

95

96



97

98